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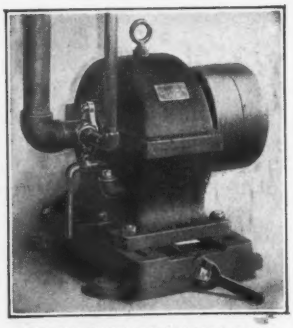
COMPRESSED AIR

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XI FEBRUARY, 1907 No. 12



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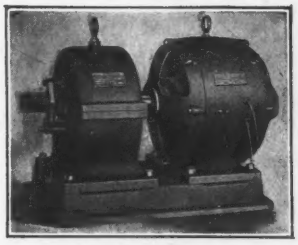

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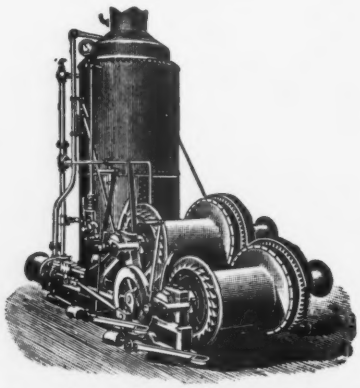

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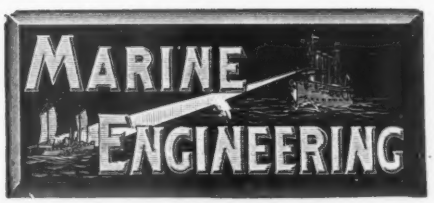

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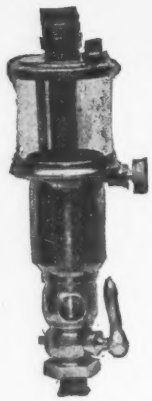

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FEBRUARY, 1907.

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THE NEW BLISS-LEAVITT TORPEDO FOR THE UNITED STATES GOVERNMENT

IT IS OPERATED BY RE-HEATED COMPRESSED AIR.

The new Bliss-Leavitt torpedo embodies the latest improvements in torpedo design and construction and also embraces many features peculiarly its own. The new weapon has been described in great detail in the Journal of United States Artillery and we are indebted also to the manufacturers, the E. W. Bliss Co., of Brooklyn, N. Y., for the illustrations which we are enabled to produce, showing the new torpedo ready for service, and also during various stages of its manufacture.

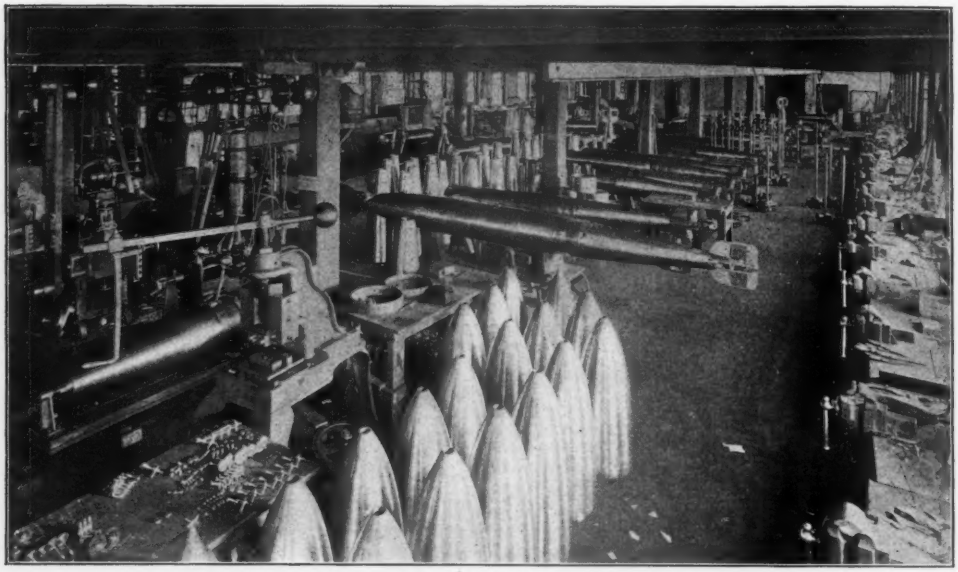
The new torpedo conforms, in its external appearance and in the leading features of its internal subdivision and method of control, to the Whitehead, but in size, power, speed, range and accuracy it far surpasses it. The 18-in. torpedoes have a length of 16 ft. 6 in. The charged weight, ready for ejection, is 1,300 lbs. They have an effective range of 2,000 yards, as against 1,500 yards for the Whitehead torpedo. Their speed is 36 knots, as against 28 knots. The 21-in. torpedoes, the largest size, have a guaranteed range of 3,600 yards, and will probably reach 4,000 yards.

The shell of these torpedoes is composed essentially of three parts, namely, a central flask, a head and an after body which contains the turbine for operating the propellors, the immersion chamber for regulating the depth of the torpedo beneath the surface of the water and the gyroscope gear by which the torpedo is automatically steered and maintained on its proper line of flight. The float, which is a little over one-half of the total length, is made of a special steel having an elastic limit of 90,000 lbs. and a tensile strength of 128,000 lbs. It is delivered to the works as a cylinder having a thickness of over 1 in. and is turned down to a thickness of 3-8 in. This is done as a precaution in order to reveal any defects in the metal. The great strength is required by the use to which the flask is to be put. It serves as a reservoir for the air operating the engine, and is charged at a pressure of 2,250 lbs. to the square inch. The ends of the flask are closed by a dished plate resembling the manhole plate of a boiler. This plate rests against a ring secured within the flask.

The after portion of the torpedo, or the tail, contains in its forward end the engine which drives the propeller. The torpedo is operated by a turbine engine of the Curtis compound type, having two wheels 11 ins. in diameter and each having 84 buckets. The wheels make 1,200 r. p. m. The engine develops 110 h. p. as against 35 to 40 in the 3-cylinder engines heretofore employed.

It should be mentioned here that the re-

markably high efficiency in speed and range of the new torpedo is due to the use of a superheating process applied to the compressed air. This consists of a flame which is automatically ignited, the instant the torpedo is launched from the tube, and which burns during the entire run. The compressed-air flask contains a burner or pot the flame of which is fed automatically with alcohol. The flow is so regulated that an even and steady temperature is maintained in the air flask.



SHOWING HEADS AND FINISHED TORPEDOES AT THE WORKS OF THE E. W. BLISS CO.

The propellor shaft is driven directly from the engine. The rear propeller is rigidly mounted on the shaft, while the forward one is carried by a sleeve. The latter propellor is moved in the opposite direction by means of the usual system of three-bevelled gears. This ensures an even keel. With the introduction of the cigar-shaped torpedo came the double driving propellers—two sets of blades carried on the same shaft, but turning in opposite directions. Rigid vertical fins were tried for the purpose of keeping the torpedo on an even keel, but not with much satisfaction.

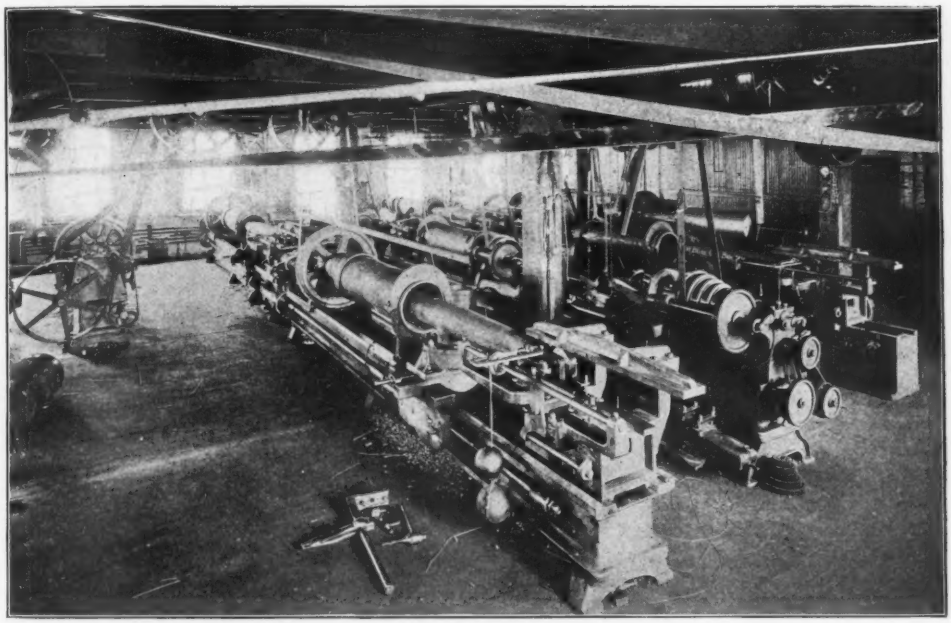
Immediately astern of the compartment containing the turbine is the apparatus for maintaining the proper depth of immersion and for steering. The regulation of the depth is effected by means of a vertical diaphragm, on one side of which is the water, which is allowed to enter by holes provided in the shell for that purpose, and on the other side a series of coiled springs, the water pressing against the diaphragm on one side, and the springs pressing the diaphragm in the opposite direction on the other side. The springs are adjusted so that their pressure shall exactly equal the pressure of the water at the given depth at which the torpedo is to travel. If the torpedo descends below that depth, the water pressure, overcoming the spring pressure, pushes the diaphragm inwardly. If the torpedo is above the desired depth, the springs overcome the water pressure, and push the diaphragm outwardly. The centre of the diaphragm is attached to levers and rods which pass through the tail of the torpedo and act on a pair of horizontal rudders, throwing them up or down, according as the diaphragm is pressed inward or outward, and thus correcting the deviation of the torpedo from the horizontal plane at which it is designed to travel.

Astern of the immersion chamber is located the steering geer. The direction of flight is preserved by a modified Obry gear. This consists of a small gyroscope wheel so connected that any deflection of the main body of

the torpedo from the true course is corrected by the action of two small rudders. The action is quick and positive. The gyroscope wheel is a sphere of steel about as large as a base-ball, and weighing less than 2½ lbs. It is driven in a most effective and ingenious way. One-half of the wheel spindle is hollow to receive air from the flask. The wheel proper is formed with a series of channels arranged in a central plane vertical to the spindle. The channels are placed tangentially so that the escaping air acts on the principle of the Barker mill. By this means a speed of 18,000 r. p. m. is obtained. If the torpedo tends to deflect to the right or to the left, this gyroscope turbine maintains its original position, and its angular motion with regard to the torpedo (or to speak more accurately, the angular motion of the torpedo about the gyroscope) serves to actuate a mechanism which turns the vertical rudders to the right or left, and corrects the deviation.

Each torpedo is provided with two heads—a practice and a war head. When fired with serious intention the war head contains a charge of 125 lbs. of wet guncotton. This head is formed of two halves, cut longitudinally and brazed together, this joint being made after a saw-tooth pattern. So accurately is this job performed that it is impossible to detect the joint being made after the piece has been finished.

The Bliss Company has perfected a very perfect machine for cutting the buckets of the turbine wheels. These buckets are made integral with the body of the wheel. The machine resembles a double spindle lathe, the work being held on the tail stock. There are two cutters which alternately recede and advance toward the rim of the wheel, which is held in a horizontal position. At the same time the cutters revolve about a common center. One cutter operates on one wall of the bucket and the other on the opposite wall. The result is a bucket perfect in contour and having highly-finished surfaces.

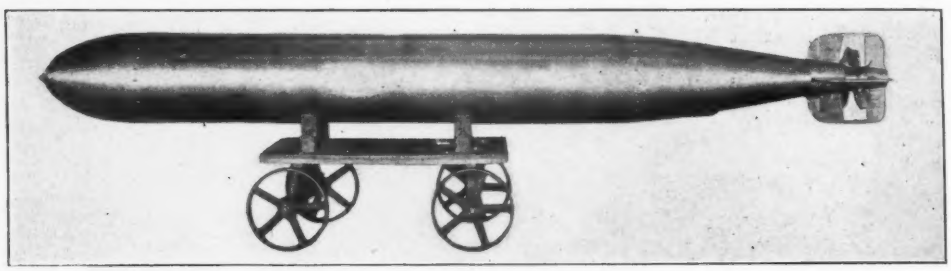


AUTOMATIC MACHINES FOR FINISHING TORPEDOES.

The above particulars are from an interesting account in the U. S. Journal of Artillery, and it will be interesting to see how these torpedoes act on trial.

WHAT THE BUYER WANTS BESIDES SPEED

Apropos of the use of compressed air on a motor-car, there is no reason why one or both brakes should not be operated by this means, says a contemporary, nor why air pressure should not be used to assist the inrush of the mixture at high piston speeds. There is also no practical difficulty in using compressed air for starting purposes, which would be a great boon. The average motorist is now more often than not quite satisfied with the speed of his vehicle, but desires that punctures shall be easily mended, and that the power of his engine should be more variable, so that speed changing should be as rare as possible. Six cylinders, or a low gear, or a light car with a powerful engine, all achieve to some extent this object; but more experiments, having in view the increased flexibility of the engine itself, are much needed. Therefore, good as all these trials and contests are, we doubt whether the buying public is much interested in them, for, as a rule, they merely prove relative power and speed, in which many modern buyers take but a languid interest.



FINISHED BLISS-LEAVITT TORPEDO.

LIQUID AIR.

At the time of the first commercial production of liquid air, several years ago, a number of untenable claims were made as to its practical applications. One of the most valuable uses to which the liquefaction of air has been put is that of the subsequent separation of the oxygen and nitrogen by fractional distillation and rectification. The possession of such a substance as liquid air, however, has proved of much value in the study of the behavior of various materials at low temperatures. It is generally assumed, for instance, that at very low temperatures metals become brittle and even fragile, and in numerous cases, the breaking of steel rails in winter weather has been attributed to this cause. By the use of a bath of liquid air it has been found practicable to test various metals and alloys at temperatures as low as 180°, and this has led to the discovery that while many steels have their tensile strength increased, their ductility lowered and their brittleness raised at low temperatures, this is not always the case. R. A. Hadfield, a well known British metallurgist, has shown that a nickel manganese steel can be made which will be as tough if not tougher at —180° C. than it is at ordinary atmospheric temperatures, and this, too, without material change in the tensile strength. Liquid air has also been used for quenching specimens after tempering, and some instructive information has been obtained about the process of hardening in this way.

HARDENING DRILLS.

Hardening an ordinary drill in sulphuric acid makes an edge that will cut tempered steel or facilitate cutting hard rock. The acid should be poured into a flat-bottomed vessel to a depth of about ⅛ inch. The point of the drill is heated to a dull cherry red, and dipped in the acid to that depth. This makes the point extremely hard while the remainder remains soft. If the point breaks, reharden but with a little less acid in the vessel.

CLEARANCE IN A COMPRESSOR AND ITS RELATION TO VOLEMETRIC EFFICIENCY

By D. W. Hering.

(Concluded from January number.)

(3) With polytropic expansion: The actual expansion curve as traced by an indicator is intermediate between the isothermal and the adiabatic, and nearer the former than the latter. The polytropic exponent n therefore to be used instead of k is between 1.41 and 1. If we could assume that the expansion curve corresponds to that of compression, with water jacketed cylinders, n might be taken at about 1.3. This value in place of k in equations (C) and (H) would determine the volumetric efficiency of the corresponding compressor, and the pressure for which the efficiency is zero. The results in the same cases as above are given in the last column of the following table, in which the volumetric efficiencies are computed to the nearest per cent., for various values of clearance and pressure, assuming the air to be initially at standard barometer pressure.

CLEARANCE C	COMPRESSION RATIO r	GAUGE PRESSURE LBS/SQ. IN.	VOLUMETRIC EFFICIENCY, E		
			ISOTHERMAL EXPANSION	ADIABATIC EXPANSION	POLYTROPIC EXPANSION n = 1.3
0.5%	14.60	200	0.93	0.97	0.965
1.0%	7.80	100	0.93	0.97	0.960
	14.60	200	0.86	0.94	0.930
2.0%	7.80	100	0.86	0.93	0.920
	14.60	200	0.73	0.89	0.860
	51.00	736	0.00	0.59	0.630
	165.40	2417	....	0.27	0.000
	255.60	3733	....	0.00	.....
5.0%	7.80	100	0.66	0.84	0.810
	11.00	147	0.50	0.78	0.730
	14.60	200	0.32	0.71	0.660
	21.00	294	0.00	0.62	0.580
	58.14	752	....	0.28	0.000
	78.17	1061	....	0.00	.....

Some of these pressures are far above what would be attempted in single stage compression; they are given to show the pressure at which the efficiency is low, or in extreme cases the limit at which it is zero, and it is easily seen that to reach a pressure as high as one hundred pounds the efficiency is materially reduced if the clearance is as large as two per cent.

The general equation $E_v = 1 - C\ (r^{\frac{1}{k}} - 1)$ can be applied to any case, with various values of C and r, by making k equal to *1* for isothermal expansion of the air in the clearancce space, or equal to n, *(say 1.3)*, in a cylinder partially cooled, or *1.41* for adiabatic expansion. The equation shows that for a given value of C the efficiency decreases as r increases; also the larger n is, the smaller $\frac{1}{n}$ becomes and the nearer E approaches to unity; so that with any given clearance and ratio of compression, the volumetric efficiency is highest if the expansion is adiabatic and lowest if it is isothermal. The figures in the table exhibit this fact also. But it is well known that for compression that is most economic of power the conditions are just the reverse of these.

A reference to the diagram shows that the steeper the expansion curve DG, the larger the intake of air V_x, and consequently the higher the volumetric efficiency. The adiabatic curve from D or D′ descends more steeply than the isothermal (D′1), and if the expanding air not only has no heat supplied to keep its temperature constant in expanding, but actually has some heat extracted from it, the curve might be even steeper than the adiabatic, the exponent in place of k would be greater than 1.41, and this would tend to offset the disadvantage in respect to volumetric efficiency that results from cooling the air while it is being compressed. From this it would seem as if the efficiency might properly be computed for adiabatic expansion, but curves of expansion as actually recorded by the indicator more commonly correspond to a value for n of *1.25* or *1.3*.

From such a discussion several methods of correcting or reducing the loss on account of clearance suggest themselves, which have been used separately or in combination: (a), with a given necessary space for clearance, its proportion to the volume traced by the piston is less the longer the stroke, so that to use as long a stroke as the power will permit is to increase volumetric efficiency; (b), if water injection is used for cooling the air during compression, the water will fill the clearance space at the end of the stroke resulting in a complete discharge of the air compressed; (c), the efficiency is higher with a small ratio of compression than with a large ratio, therefore by compressing in successive stages higher volumetric efficiency is attained than by single stage compression. For instance, referring to the table, with two per cent. clearance, single stage compression to 51 atmospheres delivers about 61 per cent. of air; the same compression in two stages, with r equal to *7.14* in each stage, would have an efficiency of 93 per cent. in each, or a final value of 86 per cent; (d), the air within the clearance

space may be provided with a channel so that it does not have its maximum pressure when the piston recedes. At the instant the stroke is completed a by-pass is opened automatically from the small space in front of the piston to the large space behind it. Air rushes from the former into the latter and the pressure in the entire cylinder is equalized, the resulting pressure being, even in high compression, but little greater than that of the atmosphere. Upon the recession of the piston the pressure on the suction side falls to that of the atmosphere and new air begins to enter the cylinder, much earlier than it would if the air in the clearance space had not been reduced in pressure by this equalizing process. The effect of this upon the volumetric efficiency is striking. The treatment briefly offered here follows von Ihering,* who has discussed this device extensively and thoroughly, and obtained results that conform closely to those obtained in practice as well as in theory by J. F. Weiss.**

Continuing with former notation,

Let CV_a = volume of clearance at either end of cylinder,

and $C'V_a$ = volume of communicating channel past the piston,

Before equalization, $CV_a\ P_1$ = product of pressure and volume of air in clearance on high pressure side of piston,

$(1 + C)\ V_a\ P_a$ = product of pressure and volume of air on other side of piston.

Let P'_1 = common pressure on both sides after equalization,

then $(1 + 2C + C')\ V_a$ = total volume of air in cylinder, both clearance spaces, and connecting channel, and

$(1 + 2C + C')\ V_a\ P'_1$ = product of pressure and volume of equalized air.

If the temperature has not been altered,

$$CV_a P_1 + (1 + C)\ V_a P_a = (1 + 2C + C')\ V_a P'_1 \quad \text{.....(I)}$$

Inserting for P_1 its value rP_a, (I) becomes

$$(Cr + 1 + C)\ V_a\ P_a = (1 + 2C + C')\ V^a\ P'_1$$

whence

$$P'_1 = \frac{1 + (1 + r)\ C}{1 + 2C + C'} P_a \quad \text{.....(J)}$$

$$\frac{P'_1}{P'_a} = r' = \frac{1 + (1 + r)\ C}{1 + 2C + C'} \quad \text{.....(K)}$$

*Die Geblaese, II Theil, 4, 5 Kap.

**Zeitschrift der Vereins deutsch Ings,, 1885.

There can be no serious error in the assumption that the equalization is accomplished with little change from the original temperature, for the waste space is small compared to the volume of the cylinder, and the equalizing is so rapid that the temperature of the air in the clearance on the compression side of the piston falls to practically the temperature of the air on the other side, while that which flows over to the rear of the piston there mingles with a large quantity at low pressure, and does not sensibly raise the temperature of the air with which it thus mixes.

The quantity of new air that will be taken into the cylinder will depend upon whether the action from this stage is isothermal, adiabatic, or intermediate between these extremes.

(1) If expansion after equalization is isothermal: When the pressure is equalized there is the clearance a volume of air CV_a at pressure P'_1. When the piston recedes the air in clearance expands, with pressure diminishing to P_a. It then has a volume $V' \frac{P'_1}{P_a} CV_a$. Calling the additional air that will be drawn in as the piston reaches the end of its transverse Vx, and placing r' for $\frac{P'_1}{P_a}$, we have $V_a + CV_a = V_x + r'CV_a$, whence

$$E_v = \frac{V_x}{V_a} = 1 - C\,(r' - 1) \quad \text{..... (L)}$$

(2) If the expansion is adiabatic: As in deducing equation (F), V' now becomes equal to $CV_a \left(\frac{P'_1}{P_a}\right)^{\frac{1}{k}}$ and

$$E_v = 1 - C\left[\left(r'\right)^{\frac{1}{k}} - 1\right] \quad \text{..... (M)}$$

(3) With polytropic expansion,

$$E_v = 1 - C\left[(r')^{\frac{1}{n}} - 1\right] \quad \text{.....(N)}$$

These last three equations for E_v are like the former ones except that they contain r' instead of r. With a given clearance and compression ratio, r' depends upon the size of the communicating channel relatively to the piston displacement. In the following table C' has been taken equal to 0.01, r' is computed from equation (K), and the volumetric efficiency under equalization of pressure compared with that without equalization. $(n = 1.3)$.

C	r	GAUGE PRESSURE	VOL. EFF. WITHOUT EQUAL'N		r'	VOL. EFF. WITH EQUALIZ'N	
			ISOTH'LY	POL'TR'LY		ISOTH'LY	POLYTR'LY
0.01	7.8	100	0.93	0.96	1.056	0.999	0.999
	14.6	200	0.86	0.93	1.122	0.999	0.999
	51.0	735	0.48	0.80	1.476	0.995	0.996
0.02	7.8	100	0.86	0.92	1.101	0.998	0.999
	14.6	200	0.73	0.86	1.250	0.995	0.998
	51.0	735	0.00	0.61	1.943	0.981	0.987
0.03	7.8	100	0.66	0.81	1.300	0.985	0.989
	14.6	200	0.32	0.66	1.600	0.970	0.978
	21.0	294	0.00	0.53	1.900	0.963	0.966

Effective as this method is in increasing volumetric efficiency, it is open to the objection that when the resistance to the piston is suddenly released by opening the by-pass, the compressor is liable to pound at the end of each stroke.

A LIQUID AIR RESCUE APPARATUS

Mr. Otto Simonie, in a paper read recently gefore the North England Institute of Mining and Mechanical Engineers, states that after some years of investigation he perfected the Aerolith, a liquid-air rescue apparatus, which weighs about 14 pounds, is easily carried on the back without any incumberance, and gives an absolutely pure and deliciously cool air supply for up to 3 hours' working. It does not contain any chemicals; it is without complications whatsoever; there is not a single valve in the whole apparatus; and its use does not require any special training.

Atmospheric air, says Mr. Simonis, liquefies at a temperature of —191 degrees C., and is compressed to about the seven-hundredth to eight-hundredth part of its original volume. Consequently 1 gallon of liquid air will evaporate into 700 or 800 gallons of atmospheric air. The principle has been applied to serve the following purpose:

A solid nickel receptacle, well insulated against atmospheric influence, capable of absorbing 1 gallon of liquid air in its asbestos-wool packing, is carried as a knapsack. A face mask, or a miners' mouthpiece, is connected through a double tube connection with this vessel; one tube leading in a diagonal direction through the vessel and thence leading into a double bag at the back of this vessel, serves for the air exhaled, which gives all its heat to the liquid air contained in the vessel, and so evaporates it; and from the top of the liquid air vessel the air evaporated is led through the other tube to the mouthpiece. The second bag is fitted with an outlet for the exhaled air mixed with any superfluous fresh air at overpressure.

Liquid air can be stored in the vacuum vessels designed by Sir James Dewar, and will then, under ordinary atmospheric conditions, not lose more than 5 or 10 per cent. by evaporation per day. Even at the present time, when no purely commercial use for liquid air has been unniversally adopted, it can be purchased for 5s. ($1.25) per gallon; whereas it can be produced by small plants at 1s. (25 cents) per gallon, and by large plants at 6d. (12½ cents), 3d. (6¼ cents) or even less per gallon. Liquid air can be transported with absolute safety by rail or car. For central rescue stations or large coal mines, however, it would certainly be desirable to erect an air liquefying plant. A plant, requiring about 8 h. p.,producing about one 1 gollon of liquid air per day, and not accupying more than 45 square feet, can be bought for about 400 pounds, ($2,000.)

One of the appliances has been purchased by the British Royal Commission on Safety in Mines for detailed experiments and research, and a large liquid air plant has been erected at Baron de Rothschild's coal mines in Austria, Aerolith apparatus being substituted for all the latest types of mining rescue appliances heretofore used.

COMPRESSED A1R AS AN INSULATOR.

A patent has been obtained by Prof. H. J. Ryan for means of producing extremely high dialectric strength. The conductors are provided with "minor" insulation of the ordinary kind, which immediately surrounds them. The electrical apparatus is mounted in a compartsufficient pressure to cause the density of such ment capable of withstanding an ample pneumatic pressure. Air (or other suitable gas) is then introduced into the compartment under sufficient pressure to cause the density of such gas to rise to and be maintained at a point by virtue of which all air (or gas) confined within the compartment has attained a dielectric strength ample to withstand the pressure to which the electric circuit thus insulated is subjected. For example, it is estimated that at a pressure of 40 atmospheres the dielectric strength of the air should be as great as linseed-oil bond paper, at 18 atmospheres it should be as good as that of micanite cloth and at 8 atmospheres it should equal that of melted paraffin or boiled linseed oil.

COMPRESSED AIR ILLNESS OR CAISSON DISEASE. *

A PHYSIOLOGICAL AND CLINICAL STUDY.

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In its simplest form, a caisson is an iron cylinder somewhat bell-shaped, open at its lower extremity and closed by sliding doors at its upper. Leading out of the upper part on one side is a chamber called an "air lock" which is separated from the interior of the caisson by an iron door and also from the outside by similar means. It is through this air lock that the men enter and leave the caisson. Between the sliding doors at the upper part or movable ceiling of the caisson and the roof is a chamber or space known as the "material lock" through which the buckets filled with soil are passed. When placed in position, the bell-shaped expansion of the caisson rests upon the bed of the river and atmospheric air under pressure is pumped in. This by displacing the water enables the men to work in a pneumatic chamber wherein they are dependent for the air they breathe upon that delivered into the caisson by pipes from an engine, and as the surplus of air escapes by the bottom of the caisson ventilation is by this means effectively secured. Frequently a caisson is a much more complicated structure than that just described. It may be, as at Newcastle upon-Tyne a large iron chamber not unlike an inverted pudding dish, the roof of which is pierced by two or three shafts, each provided in the upper part with its own air lock and material lock and with its own iron ladder, leading down to the working chamber. In visiting the viaduct works close to the railway station in Amsterdam yesterday I found that the contractors employed the Zschokke lock so that the buckets of soil are removed by a separate lock from that by which the men enter and leave the caisson. This arrangement has much to commend it.

To pass into a caisson the workmen enter the air lock and close the outer door behind them. Turning the cock of a tube which leads from the interior of the shaft and regulating its escape, the man in charge allows air to enter and to fill the air lock and when the pressure in this chamber has come to equal that inside the caisson, the inner door hitherto kept firmly closed by the greater pressure inside the caisson can now be readily opened and the men entering the shaft descend the iron ladder to the bed of the river where the work of excavation is being carried on.

A few minutes are taken up in passing through the air lock. During this period the men are undergoing what is called "compression" and as the rise of pressure ought to be gradual and not too rapid, only trained men should be allowed to work the valves of the air lock. To new comers and men who are entering upon caisson work for the first time the process of compression is unpleasant. Unless the workman has been previously taught to swallow air and pass it up his Eustachian tube into the middle ear, the pressure upon the outer side of his membrana tympani may be so great as to cause considerable pain. In some instances the drum of the ear has ruptured. During compression, the blood keeps absorbing the gases of the air until the tension of the gases therein becomes equal to that of the compressed air. When this equilibrium has been attained there is secured to the workman immunity from immediate trouble. The workman can remain in the caisson and follow his employment for a few hours without experiencing any inconvenience. There are certain things, however, that he cannot do in the caisson. He cannot whistle or shout as loudly inside the caisson as he can outside, but he can work as hard if not harder, he can ascend the iron ladder much more nimbly and with less shortness of breath inside than he could do a similar length of ladder outside the caisson.

When the workmen are coming off their shift they pass into the air lock and close the inner door. A procedure the reverse of that on entering the caisson is now gone through. The men now undergo what is called "decompression." A stopcock attached to a tube which communicates with the external air is turned and the compressed air is allowed to escape slowly. When the pressure inside the air lock equals that of the external atmosphere the outer door is opened and the men step out, enveloped in a thick fog or mist. During the

* Abstract of a Lecture delivered to the "Genootschap ter Bevordering van Natuur-, Genees- en Heelkunde", Amsterdam.

process of "decompression" the cold in the air lock is often intense—there may be a rapid fall of 40° F. of temperature. It is usually after decompression that the symptoms of caisson disease or compressed illness develop. Since symptoms never come on when the men are working in the compressed air but always after they have come out of it, the term "compressed air illness" is somewhat misleading. In small caissons only two or three men may be employed, but in great engineering operations such as the building of the railway bridge at Newcastle-upon Tyne the caissons are very large so that thirty-five men can work in them at one time. On the Tyne the working chambers were 113 feet in length, 35 in width and in height 9 feet 6 inches and their cubic capacity 23,142 feet.

The interior of the caisson was lit by electricity. Inside the caissons the men are employed in shovelling away the soil into buckets which by means of a chain and crane are lifted up through the two sets of sliding doors in the upper part of the shaft, between which is the material lock, and emptied.

From a physiological point of view the air inside the caisson ought to be as pure as possible. Pure air and plenty of it should therefore be pumped into the shafts, and the surplus air should escape readily so that ventilation of the caisson is secured and the presence of gaseous impurities that may have accidentally entered the caissons during the removal of the soil rapidly removed. On passing through certain strata offensive and dangerous gases may be encountered. On the River Tyne this has taken place on two occasions when a layer of soft coal was being excavated. There was an escape of gas, probably H_2 S, into the caissons and several of the men became ill. The amount of air pumped into the caissons must be large. Snell, the medical officer in charge of the Blackwall Tunnel, London, found that while the estimated cases of illness for 100 days were 80.9 when less than 4,000 cubic feet of fresh air per man per hour were supplied, and 22.5 when from 4,000 to 8,000 cubic feet were supplied, that the numbers fell to 8.5 when upwards of 8,000 cubic feet of air were pumped into the cylinders. It is generally held that the air requirements insisted upon by Snell are excessive and that what he considered necessary for tunnelling purposes where the excavations were carried on in the horizontal, and where the escape of surplus air was enormous, do not apply to work done in the perpendicular. ?Snell is of the opinion that 9,000 feet of fresh air per man per hour are necessary, but on the River Tyne it has been found that 1,320 cubic feet are sufficient.

Only pure air should be pumped into the caissons. When the engines that pump in the compressed air have been working for a considerable length of time they get overheated, and there is then the risk of the gases formed during the decomposition of the oil used for lubricating purposes being pumped into the caissons along with the air and these render the atmosphere not only disagreeable but dangerous to the workmen. To overcome this a layer of cold water should be made to circulate round the cylinders of the engine so as to keep the temperature low, and only high flash oils 560° F. or thereabouts should be used as lubricants. Since there is always the risk of an engine breaking down, there ought to be at all large works two or three engines ready in case of emergency to pump air into the caissons. The surplus air usually escapes in tremendous volumes from the cutting edge of the bell-shaped part of the caisson as it rests upon the bed of the river, but occasionally the caisson sinks firmly into a bed of clay, whereby the escape of air is prevented. The caisson is then said to be resting upon a "water-tight" stratum, and as no air can escape, it is absolutely necessary there should be safely valves that will act automatically, otherwise the caisson might burst and the results be disastrous. On one occasion such an accident happened in France when all the inmates were immediately killed. Safety valves are therefore placed in the upper part of the shafts, close to the air lock, and there are also safety valves on the engine, which cut out immediately the pressure inside the caisson when it has risen too high. On the Tyne the safety valves in the shafts of the caisson are so arranged as to act immediately and automatically whenever the pressure inside reaches ½ lb. higher than the maximum pressure the men have been working at for that particular day. If, for example, the men have been working in a pressure of 30 lbs. at low tide and 35 lbs. at high tide the safety valve in the shaft will act automatically when the pressure rises to 35½ lbs. When the lower portion of a caisson is resting upon a "water-tight" stratum and no air can escape, the arrangements are such inside the caisson that the air can be pumped in by two

of the three shafts and by tubes delivered at the place where the men are working, while the valves in the upper part of the third shaft are opened, and thus a circulation of air is effected. Owing to the enormous weight of some caissons and the fact that they keep sinking as excavation proceeds, it is necessary to protect the workmen inside from such accidents as might arise by the caisson tilting over to one side, or by its suddenly sinking into the soil and thus crushing the men. Strong iron girders therefore span the interior of the caisson, and the men are not allowed to work under a girder. In the middle of each girder is a large circular opening by means of which the workmen can pass from one part of the caisson to another. In small caissons, in which only two or three men can work, girders are not required. The caissons on the Tyne weighed 800 tons, and when the concrete is added to them, their weight is 10,000 tons. Since it is the caissons, when filled with concrete and their superadded concrete and masonry which become the piers of the future bridge and will ultimately have to bear such enormous weights as heavily laded railway trains, it is absolutely essential that these caissons should be substantial and that they should rest upon a firm and durable basis. In filling in the interior of the caisson with concrete carbonic acid is given off from the concrete and as the air impregnated with this gas cannot escape by the bottom of the caisson, and the gas, if retained, in the air would be harmful to the workmen in the caisson, provision has to be made for the removal of the gas and the circulation of air by opening the valves in the upper part of one of the shafts.

It is very rarely that accidents happen inside a caisson. Provision however should be made for such a contingency in the form of a sling or other contrivance, whereby injured men could be hoisted to the level of the air lock. As the caissons sink new lengths of iron tubing have to be added to the upper part of the shafts so that the air lock shall always be well above high water level mark. In tidal rivers the pressure inside the caissons rises and falls with the tide. The pressure has to be regulated according to the depth at which the men are working. One pound pressure of air displaces 2 feet four inches of water. Expressed in other terms, 10 metres of water are equivalent to 1 atmosphere. For every 33 feet of water a pressure of 15 lbs. to the square inch or 1 atmosphere is required, to keep the water out of a caisson. When men are working at a depth of 100 feet it requires a pressure of 3 atmospheres or 45 lbs. to the square inch inside the caisson. In making use of these figures it has to be remembered that the amount of pressure stated is the amount over and above that of the normal atmospheric pressure viz: 15 lbs. to the square inch, and which is not included in the amounts stated.

It is after all not such a long march from the diving bell invented by Sturmius at the beginning of the 16th century to the huge caissons now in use, and which are capable of holding 30 to 40 men. On the river Tyne there is a double shift of men, the average number of hours worked is 10¼ per day: viz.

6	A. M.	to	8.30	A. M.	= 2½ hours
9.15	A. M.		1	P. M.	= 3¾ "
2	P. M.		6	P. M.	= 4 "

Total per day = 10¼ hours.

The working hours or shifts are, I think, better arranged here than in Newcastle. In Amsterdam I find the men work for 4 hours, are off for 8 hours and again work 4 hours. I also observed with pleasure that the men coming out of the air lock all wore round their shoulders a blanket shawl provided for them by the employers.

HYGIENE OF COMPRESSED AIR.

The influence of compressed air upon man has been an interesting study to the practical engineer, the physicist, and physiologist. At 3 atmospheres it is impossible to whistle, and the voice has a nasal twang. Sounds are not conveyed with their usual intensity. Opinions differ as to whether the men are as easily fatigued. It is generally admitted that they ascend the ladders inside the caisson with greater ease and less breathlessness than they can do outside. American writers have stated that at 40 lbs. pressure taste and smell lose their acuteness, but on this point opinions are divided. The workmen do not hear so well owing to the diminished rate of vibration of the membrana tympani. Owing to the increased velocity of the waves the pitch of the sound is higher. Respiration is slightly increased. Under a pressure of 33 lbs. it may rise to 21 per minute, probably in consequence of a diminished elimination of carbonic acid. If the pulse rate rises it is only for a very short time. In watching the circulation through the web of

the foot of a frog subjected to 200 to 300 lbs. pressure, the circulation after the first few minutes seemed to me to proceed without any apparent change. Dr. Andrew H. Smith, of New York, believes that the volume of the pulse is smaller since the compressed air prevents the expansion of the artery, but this would impose more work upon the heart, and thus recovery of the volume would take place. Owing to the saturation of the air in the caisson with moisture, the hard character of the work, and that evaporation from the skin is impaired, there is a slight rise of the body temperature according to some authors. This was not found to be the case in Hill and Macleod's experiments. As the clothing of the men becomes permeated with moisture, and there is a rapid fall of temperature inside the air dock on coming out during decompression the men run the risk of becoming chilled. Working in compressed air is said to improve the appetite. This would suggest increased waste of tissue. Under 4 atmospheres of compressed air Hill and Macleod found in one animal a decided increase in the daily elimination of urea, but not in others. Paul Bert found the amount of urea decreased and Snell no change at all. There is nothing constant therefore about the nitrogeneous waste. The output of CO_2 is diminished. Hill and Macleod exposed muscle nerve preparations of frogs to 50 to 60 atmospheres of oxygen for one hour, when they found the muscle still directly and indirectly excitable. There was no alteration in the latent period of stimulation, nor in the rate of conduction in the nerve. A frog's heart exposed to the same high pressure continued to beat rhythmically for nearly two hours. After decompression the vagus was not found to be excitable owing probably to paralysis of the nerve terminations in the heart.

Exposure to high pressures of oxygen produces convulsions in most animals when in the compressed air chamber, and these may continue after rapid decompression. Convulsions are not so likely to be produced in animals after rapid decompression from compressed atmospheric air, but the respiration may become embarrased, and there may be paralysis or death. With compressed atmospheric air it was found that convulsions did not occur until 12 atmospheres were reached owing to intoxication from the oxygen being too gradual. After rapid decompression from atmospheric air animals become convulsed owing to frothing of gas in the heart and nervous system. The convulsions end in paralysis, but after rapid decompression from oxygen the convulsions still continue because the oxygen set free can maintain the life of the tissues. In the decompression of atmospheric air it is nitrogen that is set free. This gas which forms 79 per cent and therefore the bulk of atmospheric air is, when an animal is subjected to compressed air, absorbed according to the law of partial pressures. "Under 1 atmosphere 100 c.c. of blood dissolve 1.23 c.c. of N_2 : under 4 atmospheres 4.92 c.c. of N_2. The same blood gives up 3.66 c.c. of N_2 when decompressed from 4 atmospheres to 1 atmosphere. The whole blood in the body of a man weighing 70 kilos would give up 130 c.c. of N_2".

The tissues of the body take up N_2 more slowly but in larger quantity than the blood, ten times as much, hence the danger of too long shifts for men working in caissons. The proof that the gas which is liberated in the blood and tissues after rapid decompression is mainly nitrogen has been proved by the analysis of the gases of the blood obtained from the right heart of a dog which had been instantly killed by the bursting of a caisson Hill found 15.2 per cent. of CO_2; 82.8 per cent. of N_2 and 2 per cent. of O_2. Any oxygen set free during rapid decompression of atmospheric air is at once absorbed by the tissues.

SYMPTOMATOLOGY.

When men are undergoing "compression" or are passing through the air lock into the caisson, beyond experiencing unpleasant sensations due to pressure upon the membrana tympani and which can be diminished or prevented by swallowing air and transmitting it by the Eustachian tube into the middle ear, no symptoms arise during this procedure. Nor do the men suffer when in the caisson owing to the fact that the pressure is evenly transmitted to all parts of the body by the fluids of the body. It is after the men have finished their work, have undergone decompression and come out of the air lock that symptoms develop. These may show themselves in a few minutes, or not for some time, an hour or more after decompression. It is an interesting fact that the men who work the air lock and the lower sliding doors of the material lock do not suffer from caisson disease. They are exposed to the same pressure as the men inside the caisson, but

they have no hard physical work to do. This freedom from compressed air illness on the part of these men raises the question as to how far muscular fatigue is a predisposing cause of caisson disease. There are grades of caisson disease. In the minor forms the men complain of severe pains in the muscles of the limbs and trunk, which they call "bends," and which experience has taught them will disappear if they allow themselves to be "recompressed." Occasionally there is epistaxis and bleeding from the ears. As stated in a previous part of this lecture the symptoms may come on a few minutes after decompression or shortly after coming out of the air lock, or it may be that the workman is on his way home or has reached home and is at a meal, when he is suddenly seized with severe pains, becomes paralyzed or has a bleeding from the nose or lungs. The loss of power usually affects the legs: once developed the paraplegia is for the moment complete, and is attended by retention of the urine, requiring the use of the catheter. In the minor forms of caisson disease the paralysis disappears in a few days or weeks, but in the severer forms it may persist for several months, be accompanied by loss of sensation and also by the development of ulcers on the heels, bedsores on the buttocks and yet the patient may ultimately recover. The skin of the feet and lower part of the legs often cracks and is thrown off in thick flakes.

Occasionally the symptoms come on immediately after a workman leaves the air lock. The man staggers as if intoxicated and he falls. On being picked up by his comrades, he is found to be unconscious, his breathing is embarrassed, sometimes stertorous; his pupils are dilated, pulse rapid and feeble, and the skin cold. Under these circumstances death may occur without consciousness ever being regained. Or it may be that the workman is so enfeebled generally that he is unable to walk, he is found to have become suddenly childish and weak mentally. I have seen men become the subjects of acute delirium and remain maniacal for two to three days. Occasionally the men have complained of loss of part of the field of vision, without any aphthalmoscopic changes to explain the defect, also of diplopia and facial paralysis. The symptoms of compressed air illness may be ushered in by vertigo vomiting or difficulty of breathing, accompanied by cyanosis. The men sometimes become simply timid and hysterical or their complaint is of such an indefinite character that it is difficult to say whether they are not malingering. When the muscular pains are severe, the men are extremely restless. They roll about in agony and can only be quieted by a hypodermic injection of morphia.

THE PASSING OF THE BROOM

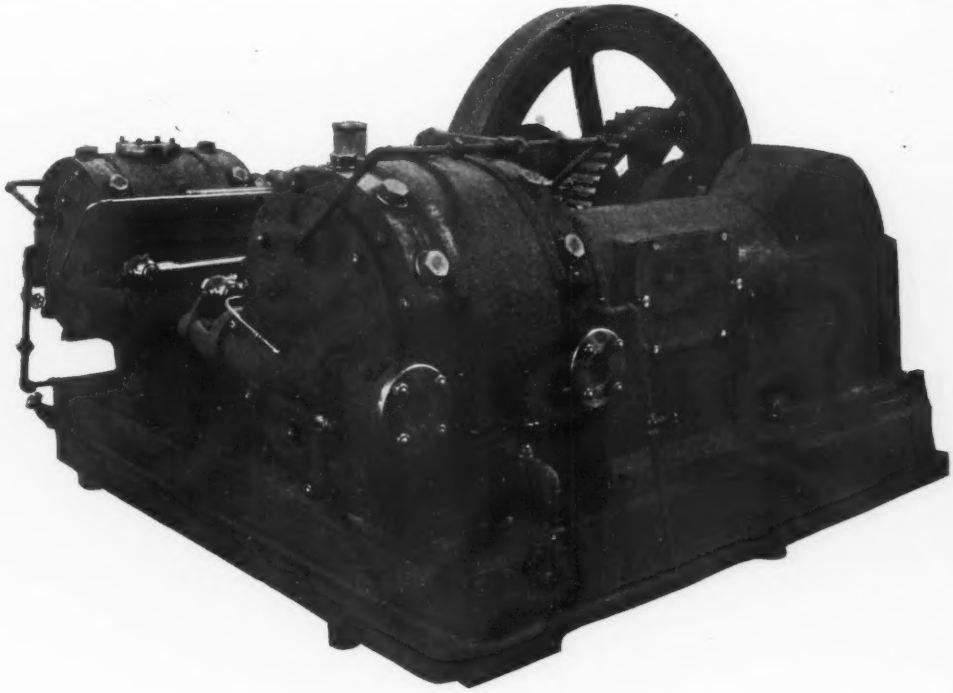
That vacuum cleaners are driving the broom out of use is asserted by a writer in *The Lancet* (London, November 24)' who congratulates the world on the change, on hygenic grounds. He writes:

"The broom threatens soon to be as obsolete as the old copper warming-pan, judging from the number of vacuum dust-removers which are being placed upon the market. The change is one which must meet with the unqualified approval of all who know what a breeding-ground of disease is the common dust of our houses. Every housewife who is possessed of cleanly instincts should welcome an aparatus which removes dust instead of scattering it in all directions, lost to the senses, so to speak for a time by its attenuation in air, only sooner or later to settle again on the shelves, pictures, curtains, and carpets in a thin film. Moreover, the removel of dust and its collection in a receptacle by means of the vacuum-cleaner permit of its absolute destruction by fire. Bacteriological science can easily demonstrate the existence of disease germs in common household dust and there is evidence of an eminently practical character that dust is otherwse a source of disease; there could hardly be a more effectual means of spreading the infective and irritating particles than the old-fashioned broom. The method is not only unsanitary but absurd from the point of view of its aplication. The broom may clean the surface of a carpet, chair, or curtain effectually enough, but the dust is only removed to be scattered elsewhere and to be spread over an even wider area than before. The great and important difference between the cult of the broom and the vacuum cleaner may be summed up by saying that, while the former is calculated to spread disease, the latter enables the dust and its pathogenic contents to be removed and destroyed by fire. The method of removing dust by means of the vacuum cleaner has therefore everything to be said in its favor and it is to be hoped that the apparatus will become so moderate in price as to be within reach of all. The passing of

the broom, when it comes, to be *un fait accompli,* will be a fact of great sanitary significance."

A NEW BLAISDELL AIR COMPRESSOR

It will probably be of interest to users of compressed air to know of a new self-oiling air compressor which is now being manufactured by the Blaisdell Machinery Company of Bradford, Pa. This company was the first to make a self-oiling machine, and the one here illustrated represents the latest ideas in design and construction of this class of compressor. It is known as "Class C" and the machine shown in the accompanying illustration is designed to be operated by an 85 H. P. Westinghouse gas engine. The cylinders are 18 and 12 x 12 and have a displacement of 519 cu. ft. of free air per minute when the compressor is operating at 150 r. p. m.

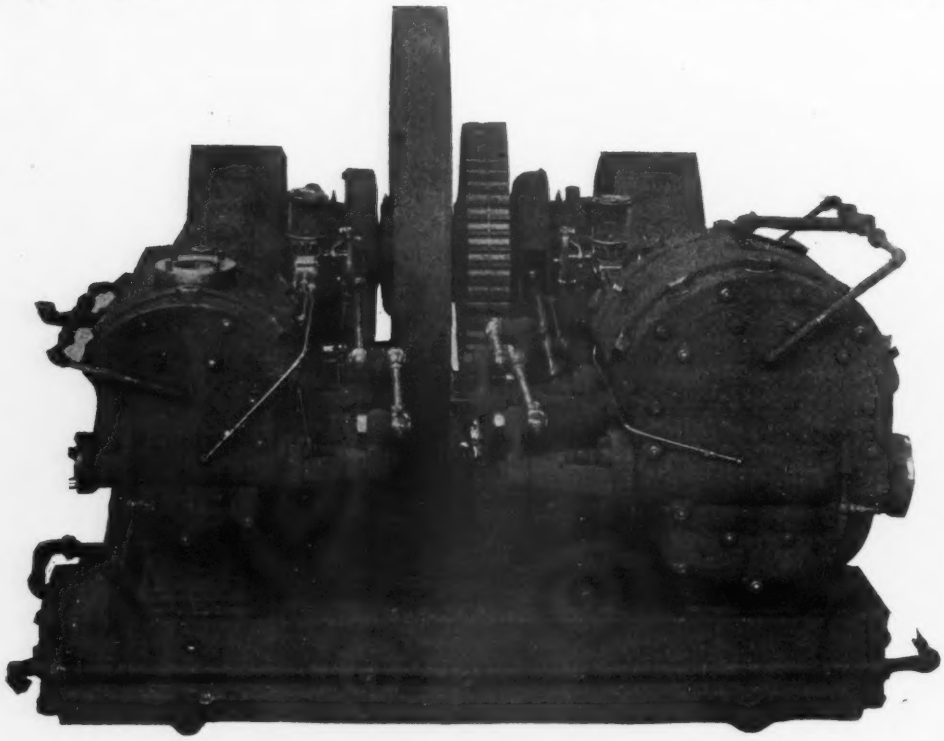


SIDE VIEW OF NEW BLAISDELL AIR COMPRESSOR.

The frame of the machine is entirely enclosed, allowing the cross-head pin, slides, main bearings and crank pins to run in a bath of oil, which is fed to the parts in copious quantities by the crank discs which dip into the oil chamber. The oil feed to all parts is positive and lubrication starts and stops with the machine without attention. The oil, after being used, drains back to the chamber, around which is cast a raised rib, which the oil must overflow in order to re-enter the chamber, thereby depositing any sediment outside the rim, from whence it may be drawn off. Any drip from the front stuffing box enters and can be drawn off from a separate chamber, preventing it from entering the oil chamber. This inclosed type of frame also thoroughly protects the parts from dust and grit, preventing undue wear and allowing the machine to be located where most convenient. Cross-head slides are of the bored type, rigidly supported. Pillow blocks are of the heavy duty type, well tied into body of frame, the jaws being rigidly held by the interlocking bearing cap. On all single compressors these frames are equipped with double bearings to permit of center crank construction.

The compressor is mounted on a substantial cast iron sub-base in which is contained the intercooler, situated directly under the air cylinders. This cooler is made up of a large num-

ber of standard brass condenser tubes through which the cooling water passes. Tubes are placed close together, and by means of deflector, or baffle, plates the air is passed between the tubes in the form of thin sheets. The cooling surface is very large and the volume of storage space is ample to supply the high pressure cylinder without causing the air to pass through the cooler too rapidly. The intercooler is entirely self-contained and may readily be removed from the sub-base if desired. Furthermore, it is equipped with a safety valve of approved pattern.



REAR VIEW OF NEW BLAISDELL AIR COMPATSSOR.

The main bearings are of a design and construction which is a decided improvement over usual methods. They are of the half-box type, fitted with removable cast iron shells lined with babbitt, which is piened in and carefully bored. Bearing surfaces are unusually large and are so designed that the oil is not wiped off by close-fitting edges. They are adjusted for wear by wedge and screw, the latter being provided with a lock nut.

The cross-head is a steel casting of the box pattern, fitted with removable cast iron shoes, both top and bottom, having large wearing surfaces, and are adjustable by wedge and screw, the bearing surfaces being provided with alternate strips of babbitt metal. The wedge screw is firmly locked, and is relieved of all working strains by two heavy tie bolts which pass through the cross-head body and grip the shoe. The cross-head pin is of the best machine steel, hardened; it is of large diameter and is drawn into the cross-head on a taper being easily removed.

The pistons are cast hollow in one piece and are fitted with re-turned cast iron snap rings, which have a perfect bearing and uniform pressure on the cylinder walls at all points.

The air cylinders are cast in one piece, both cylinders and heads being thoroughly water jacketed. They are fitted with Corliss air inlet valves and poppet outlet valves; the Corliss valves being contained in the cylinder heads which have separate water jaekets from the barrel.

The weight of the compressor shown in the accompanying illustrations, machine and sub-base complete, is 16,500 lbs.

COMPRESSED AIR

Established 1896.

A monthly magazine devoted to the useful applications of compressed air.

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London Office, 114 Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

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Vol. XI. FEBRUARY, 1907. No. 11.

TEN months ago we notified our readers of a change in management and of the removal of our offices to 90-92 West Broadway. It now becomes necessary to announce another change in address, our old offices having become entirely inadequate to accommodate the new members which we are adding to our staff.

The past ten months have witnessed a remarkable growth both in the number of our subscribers and in the number of advertisers. But, more important than either of these, is the fact that COMPRESSED AIR is meeting with the approval of its old subscribers as evidenced by the small number who have discontinued their subscriptions and the large number who have written us complimentary letters and promptly enclosed the subscription price for another year.

This is particularly gratifying to us as we are endeavoring with all the means at our disposal to produce a magazine which will correctly chronicle every phase of the application of compressed air to modern industrial requirements. But in order to do this adequately, it is necessary that our readers co-operate with us by informing us of interesting and valuable uses for pneumatic power which their experience may have developed. It is only by thus interchanging ideas that COMPRESSED AIR may serve its readers to their mutual benefit.

THE ART OF CUTTING METALS

Probably one of the most important papers ever presented before an engineering society was the one read before the American Society of Mechanical Enginers at its last annual meeting, December, 1906, on "The Art of Cutting Metals," by Mr. Frederick W. Taylor, retiring President of the Society. While this paper would be obviously out of place if reprinted in COMPRESSED AIR, we do not feel that we can let it go by unnoticed, as we have no doubt that many of our readers will not only be glad to know of it, but will be able to profit to a great extent by the information which Mr. Taylor has compiled.

Mr. Henry R. Towne, in commenting on this paper, says: "Mr. Taylor's paper on 'The Art of Cutting Metals' is a masterpiece. Based on what is undoubtedly the longest, largest, and most exhaustive series of experiments ever conducted in this field, its summary of the conclusions deduced therefrom embodies the most important contribution to our knowledge of this subject which has ever been made. The subject itself relates to the foundation on which all our metal working industries are built."

"About sixty years ago American invention lifted one of the earliest and most universal of the manual arts from the plane on which it had stood from the dawn of civilization to the high level of modern mechanical industry. This was the achievement of the sewing machine. About thirty years ago American invention again took one of the oldest of the manual arts, that of writing, and brought it fairly within the scope of modern mechanical development. This was the achievement of the typewriting machine. The art of forming and tempering metal tools undoubtedly is coeval with the passing of the stone age, and therefore in antiquity is at least as old, if, indeed, it does not outrank the arts of sewing and writing. Like them, it has remained unchanged from the beginning until nearly the present time. The work of Mr. Taylor and his associates has lifted it at once from the plane of empiricism and tradition to the high level of modern science, and apparently has gone far to reduce it almost to an exact science. In no other field of original research, that I can recall, has investigation, starting from so low a point, attained so high a level as the result of a single continued effort. * * * The title of Mr. Taylor's paper does scant justice to the scope of the work which it re-

cords, for incidental to its main purpose this work included subordinate investigations hardly less radical, even if of less importance, than the main issue. Chief among these was the development of what is now best known as the 'Taylor System' of shop management, itself a discovery of fundamental importance, the influence of which will be felt ultimately and permanently, not only in the metal trades, but probably in all organized industry."

An instance of the efficiency of the Taylor System is cited by Mr. Calvin W. Rice, Secretary of the Society, who stated that he recently had the opportunity to visit the Sayles Bleacheries, located near Pawtucket, R. I., where the Taylor System is being introduced. He was permitted to compare the record of the output of certain rooms before they began to introduce the system and after it was put into operation, and these records showed that even in the most simple matters, namely, folding cloth, the increase in output was very great, individual cases five-fold, and the increase of individual wages 20 to 40 per cent., the cost per piece being materially reduced.

Improvements in other bleacheries have of course been going on all this while, so that the Sayles have no monopoly in this regard, but what they do have over their neighbors is a better class of employees, with higher individual wages, freedom from labor difficulties, because the Taylor System does not conflict with the bulls of labor unions, and, more than all, an organization capable of indefinite expansion to meet any emergency.

While we regret that we are unable to reproduce this paper in COMPRESSED AIR, we take pleasure in informing our readers that it is being reprinted in full in the *Iron Trade Review*, and those who are interested in the subject and who do not have access to the Transactions of the American Society of Mechanical Engineers will derive much benefit from reading the paper as it comes out in serial form in the above-mentioned periodical.

We regret to announce the death of Mr. James Clayton, who died at his home in Brooklyn, N. Y., December 31, 1906 at the age of 85 years. In the December number of COMPRESSED AIR we were privileged to reproduce a photograph of Mr. Clayton and to publish an account of his achievements. He was born in Shropshire, England, and came to this country in 1849, going to Nevada, where he was successful in gold mining operations. In 1864 Mr. Clayton began manufacturing water and other pumps in Brooklyn. He invented many kinds of pumps and mechanical processes, the best known invention being the air compressor which bears his name.

MACHINISTS ARE WELL PAID.

In every factory, mill, shop, pressroom, power room, everywhere that complicated machinery is in active use, the machinery expert has been needed and supplied, says the Chicago Tribune. From the water pump in the basement of some Chicago skyscraper to the gangsaw in a country sawmill, from the diepress in some sweat shop to the ore crusher in an Alaska gold mine, is the range of the machine expert. His is the hand that effects the direct marvel of the machine, whether its mission be to cut out cap or hat patterns or 12-inch building timbers, whether it be to supply water to a city building or eat up the rock of half a mountain side. Kipling has sung the song of men in many mechanical lines of endeavor, but he overlooked the craft that would have been most prolific of inspiration—that of the machine expert.

That part of Chicago which lies just across the river on the west side and is known as the machine district is the habitat of the machine expert in Chicago. Here he originates. In the factories, shops, salesrooms, foundries, offices of this dark, machine-filled section he learns his trade. Here also he is employed. From here he may be sent to almost any part of the world where machinery is used to put into practice the knowledge gained in the vicinity of Jefferson street, Chicago. There are several hundred kinds of him, just as there are several hundred kinds of machines that he is master of.

His age runs from 22, which is the age of the near genius in the craft, to 72, when he is a veteran of fifty years' experience, gray-headed, spectacled, bowed and efficient. There is a man with a crooked spine who draws $80 every week he works because he and he alone in a force of a score of employes knows just how a new wool carding machine should be set up, and he can do the work with his own hands. His crooked back doesn't hurt him, either, in the opinion of his employers or his employers' patrons. He can make the machines that his firm sells "run." It wouldn't

make any difference if he was bereft of his hands and did the work with his toes; the thing is, he does it. Incidentally, he got his crooked back through breaking in, or rather trying to break in a new man in the trade. The apprentice turned on the power before the last nut was tightly screwed on. So one of the many pieces of the machine, operated at a speed of 200 motions an hour, tore loose and struck the expert. He was incapacitated for two months, and his firm lost much money because of it.

The machine expert is a specialist. This is an age of specialism, and nowhere is specializing carried on to such a fine point as in the world of machinery. So intricate are the workings and purposes of many machines that to thoroughly master one is often the work of a lifetime. In the largest and most complicated of machines it is not unusual to find several specialists necessary to its proper erection and operation, one having been unable to achieve proficiency in the whole. In such cases each man is a specialist in his part, and just as a surgeon may be an expert in cranial operation and know little about the sucessful treatment of appendicitis, he may know no more about the machine as a total than is necessary to his own special part. But in most cases some expert, who may or may not have a gang of skilled workmen under him, is responsible for the machine.

The expert invariably is exployed by the makers or selling agents of a machine. In some instances the purchaser of a machine pays the cost of setting it up, but the most usual course is to sell it on condition that the seller put it into operation. It all amounts to about the same, the man who buys is of course the man who pays. So with a $2,000 machine sold in Michigan may go a $50 per week machine expert. His services may be required for a week, it may be but a day. But whatever the time, he stays until he has seen the power turned into the machine, has seen it turn out the work for which it was made and until the purchaser is satisfied that he is getting what he is paying for. Then he packs his grip and hastens back to Canal street, possibly to be sent to Nebraska the next day on the same kind of errand.

Sometimes the expert is salesman as well. In that case he looks after the delivery and running of the machine he sells. Sometimes he is a partner of the firm, for a thorough knowledge of the machinery handled by a house is a pretty good sort of recommendation for a partnership. But in most cases he is just an expert, paid for setting up machines. In the larger houses this is his function exclusively; in the smaller ones, where his services are not continually required in such work, he is employed in the shop, store or office when not employed at his regular craft. Or he may be busy repairing machines when not actually setting them up.

Usually he begins as an apprentice in the shop. Then he becomes a full-fledged workman, and it is then that he shows that he is of the stuff that makes experts or does not. He usually attracts attention by showing that he knows more about the machines made in his shop than his fellow-workmen. Although the mechanic is a skilled and intelligent workman, the man who knows the workings of a machine of which he makes perhaps one part is the exception.

It is from the pick of these exceptions that the machine expert comes.

A few are graduates of technical institutions but the majority have come up from the ground, beginning by running a machine that made a minor part of the machine which afterward they will know so well as to be able to make one if given time. This is just what the expert must be able to do. If he does not, he can not successfully prosecute his work. He must know how every part in his machine is constructed, what its strength, how it shall be adjusted, how it shall run and how the whole shall run when put together. In making repairs he frequently makes with his own hands delicate parts. He is in reality the professor of mechanics; he knows how it all is done and why.

His salary may vary from $20 to $100 per week. If he is exceptionally good he will get the latter figure; if exceptionally poor the former will be his price. His position varies as machines and firms vary. In the best and largest he is a person of importance; in the smallest he is just one grade above the common workman. He occasionally suffers financially during times of industrial depression and sometimes he is worked to death on hurry orders. Generally he can't keep himself continually employed and his vocation is not more crowded than other vocations where brains and special talent are necessary.

NEW PUBLICATIONS

Self-Propelled Vehicles, a practical treatise on all forms of automobiles, by James E. Homans, A. M., 5th Revised Edition, entirely rewritten. 598 pages, with 500 illustrations and diagrams. Published by Theodore Audel & Co., 63 Fifth Ave., New York.

As an introduction to the more important parts of the work the author gives a brief history of the motor car, after which he takes up the subjects of transmission of power, stearing gear, theory of the gas engine, carburetters, gas engine design, etc. In all these parts the author has emphasized the practical aspects of motor vehicles of all powers, confining his space to the discussion of matters fundamental in construction and management.

The book is not confined to the subject of gasolene automobiles, but treats of electrical and steam vehicles with equal thoroughness. Recognizing, however, that the gasolene motor car is the typical automobile of the present day, considerable space has been devoted to a complete discussion of its theory and operation, and an extended chapter on "Gasolene Engine Management," the latter covering, virtually, all forms of difficulty liable to occur under service conditions is included. Anyone reading this chapter can derive an intelligent conception of the requirements of an expert driver, and will find numerous points of information, usually obtainable only by a long and varied experience.

All subjects are most adequately illustrated and we should think the work admirably suited as an educational treatise for owners and drivers of automobiles as well as for those interested in the manufacture and design of these vehicles.

TRADE PUBLICATIONS

Wendell & MacDuffie, 26 Cortlandt St., New York—Catalog No. 16. 24-pages, 4x9 describing Reinforced Corrugated Asbestos Sheathing, which is now being used extensively as a substitute for corrugated iron for roofing and siding of power stations, carbarns, train-sheds, elevators, rolling mills, and similar structures of medium cost, or any building for which corrugated iron has heretofore been used. The catalog also covers the subjects of "Century" Asbestos Shingles, Asbestos Bus Bar Compartment Doors, various methods of laying shingles, etc. Accompanying the catalog is a handsome colored supplement illustrating the exact appearance of the above materials.

Sprague Electric Company, 527 West 34th St., New York.—Booklets describing Electric Hoists and Cranes, Electric Motors for driving ventilating fans and blowers, Flexible Steel Armored Hose for steam and compressed air.

Ingersoll-Rand Company, 11 Broadway, New York.—Catalog No. 36, devoted to Ingersoll-Sergeant Air and Gas Compressors. This book contains 184 pages, covering the complete line of Ingersoll-Sergeant Compressors, a very brief description of each of the nine classes being given, followed by tables of sizes, capacities, weights, etc., with illustrations of typical machines and representative plants. An unusual feature of this publication is the number of actual illustrations of machinery covering almost every line of industrial activity. Two very important articles of an engineering character are included. The first of these deals with "Some Important Elements of Economy in the Straight Line and Duplex Types of Compound Air Compressors," and the other is on "Compound Air Compression," and goes exhaustively into the details of this important subject.

Catalog No. 91, describing the Davis Calyx Diamondless Core Drills, for prospecting mineral lands and for bridge, sewer, or subway soundings and for drilling artesian wells. This catalog contains 62 pages of thoroughly illustrated text matter and goes into the subject in great detail.

Crandall Packing Company, Palmyra, New York.—Catalog, 6x9, describing Crandall Packings for all classes of service. This book contains 80 pages, is fully illustrated, and gives the price per pound of each class of packing, as well as prices on rubber belting, leather belting, steam and water hose, gage glasses, etc.

Sullivan Machinery Company, Railway Exchange Bldg., Chicago, Ill.—Catalog No. 55, 158 pages, 6x9, containing a full account of the advantages of their Diamond Core Drills for prospecting and well drilling. There is also given much valuable information on the cost of diamond drilling, prospecting by contract, records of performance, etc.

Harris Air Pump Company, 62 Lombard St., Indianapolis, Ind.—Small booklet, stating the advantages of the Harris Air Pump Company's system for lifting water from deep wells.

The Dayton Globe Iron Works Company, Dayton, Ohio.—Tables of Power of the New American Turbine, covering the Balanced Flutter Gate, Cylinder Gate, Wicket Gate and New American High Head Types, as manufactured by this company. These Turbines are designed for water power, and the booklet contains much valuable information regarding weirs, velocities of water, discharge of water, and other data of value to users of water power.

Hanna Engineering Works, 820 Elston Ave., Chicago, Ill.—This concern is issuing a bulletin describing two new styles of riveters which they are just placing on the market. One is particularly adapted to boiler and tank work, as it is made in almost any reach, gap and pressure. The other machine is a special lattice riveter for doing work in very close quarters. Another bulletin issued by the above company is one describing the Hanna Radial Reamer for reaming rivet holes after punching.

The Ridgway Dynamo & Engine Company, Ridgway, Pa.—20-page illustrated bulletin describing the McEwen Engine. The bulletin describes the construction of the engine thoroughly and contains many tables on horse-power of different size cylinders and for various cut-offs.

TECHNICAL PUBLICITY ASSOCIATION

At a recent meeting of the Technical Publicity Association, at the Aldine Association Rooms, 111 Fifth Ave., New York, the subject of "The Value of Circulars and Printed Matter" was taken up. Mr. Frank Vreeland Art Editor of the *American Printer,* spoke of the commercial value of beauty in typography and Walter Gilliss, President of the *Gilliss Press,* New York, made some remarks about limited editions.

The companies represented at the dinner by members of the Association, which is confined to those connected with the advertising departments of machinery manufacturing industries, were as follows: Ingersoll-Rand Co., F. R. Almond Mfg. Co., Pope Mfg. Co., H. W. Johns-Manville Co., Yale & Towne Mfg. Co., John A Roebling's Sons Co., American Locomotive Co., General Electric Co., Patterson, Gottfried & Hunter, New York Edison Co., M. H. Treadwell Co., Crocker-Wheeler Co., A. S. Cameron Steam Pump Works and the Lidgerwood Mfg. Co.

The meeting developed into an "experience meeting," and many of the members told of their methods and results with printed matter and circular letters. As usual at the monthly meetings, several new members were elected.

COMPRESSED AIR is in receipt of several very attractive miniature catalogs from the A. S. Cameron Steam Pump Works, and we are informed that these catalogs are printed in numerous languages. The English edition, from the cover view, represents an oak board with panels in gun metal effect, having the oak leaves intertwining the acorn-shaped air chamber of the Cameron pump.

These descriptive catalogs are replete with information and prices regarding the types of a score of pumps in general demand, half-tone illustrations and sectional cuts being used to illustrate the mechanism.

MR. Francis F. Coleman, formerly with the Westinghouse and Allis-Chalmers Companies, and recently with the Taylor Eng. Co., has joined the Lidgerwood Mfg. Co. as Publicity Manager. Mr. Coleman was at one time Editor of the *Electrical Age,* and is the author of several publications of note, among which might be mentioned "The Book of The Four Powers" and "The Power of the Subway." Mr. Coleman was the organizer of the Machinery Club, and was active in bringing about the organization of the United Exhibitors' Association, at the Louisiana Purchase Exhibition, where he represented the Allis-Chalmers Company. He is a member of the Technical Publicity Association, and brings to his company a large amount of experience as well as an interesting literary style acquired during many years of service with the *New York Press* and other metropolitan newspapers. Mr. Coleman's headquarters are at the main office of the Lidgerwood Mfg. Co., 96 Liberty St., New York.

CASSIER'S MAGAZINE

Cassier's Magazine has been sold by the estate of the late Louis Cassier to Henry Harrison Suplee, for many years the technical editor of the *Engineering Magazine,* and James Van Vorst Colwell, recently works manager for the C. W. Hunt Company, and the pub-

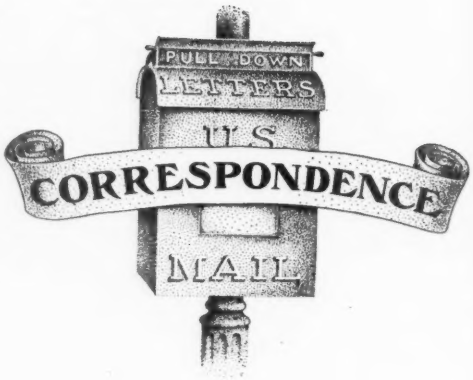
lication will be continued, as heretofore, by the Cassier Magazine Company, 3 West Twenty-ninth street, New York. The editorial conduct of the magazine will be in the hands of Mr. Suplee, who brings to this work a wide experience, both in the practice of mechanical engineering and of technical journalism, while the business department will be directed by Mr. Colwell. The first issue of the magazine under the new management was the January number.

LUBRICATION

The proper lubrication of mine-car wheels and machine parts at a colliery is a most important consideration, and it is probable that few other individual factors so directly affect the cost of production per ton. It is not logical to economize in the various small items of operation and neglect so important an action as the proper lubrication of cars and machinery. One authority claims that about one-half the power expended in mill or mine is lost in overcoming the friction of lubricated surfaces. He also adds that by changing from a poor to a good lubricant the loss is cut to one-fourth the power expended.

It is impossible to give any fixed rules regulating the selection of a proper oil for mine lubrication; however, it is generally believed that a dark-colored oil is of greater value than one that has been filtered to a red or yellowish color, for the process of filteration is not only expensive, but removes a considerable percentage of the lubricating value. Oil of a free-running nature is best for engine bearings, as it reaches the parts more quickly than oil of a sluggish nature. Where the bearings are open and the oil is applied direct, oil of a ciscid nature is more suitable.

The waste incurred in the lubrication of mine cars is hard to avoid when old-fashioned car axles are employed, and this fact makes the buyer hesitate before adopting an expensive oil. Such action is not economy after all, and although some expense is incurred when mine cars are equipped with a self-oiling arrangement, where the oil is supplied from a reservoir in the axle or better still in the web of the wheel, still the eventual saving in power and decrease in wear and waste will more than balance any expenditure.



To the Editor of Compressed Air:

DEAR SIR—We wish to call your attention to an error in statement of fact, which occurred in your "Chippings" (I think that is the name) in the December number. The paragraph referred to states that the deepest bore hole in the world, some 5,950 ft., was recently bored in Germany.

There are at least two holes deeper than this. One of these, which was bored in the Transvaal, by John Schanke, an American contractor, to reach the Rand gold formation, was completed this year. A Sullivan Class P machine was used. This hole is 6,340 ft. in depth, and the size of core extracted ranged in diameter from 2 in. at the top to 1⅜ in. at the bottom.

The deepest hole of which we have any record was bored in Silesia, several years ago, and is some 6,700 ft. deep. We believe that this hole was also bored by a diamond drill, although it was not of American make.

If you care to take any further notice of this matter, the above may be interesting.

Yours very truly,
SULLIVAN MACHINERY COMPANY,
(Signed), S. P. King.

To the Editor of Compressed Air:

DEAR SIR:—Referring to your October issue of COMPRESSED AIR, and the article written by Edward F. Schaefer, M. M. E., on Vacuum Peculiarities, I wish to call yaur attention to one or two general statements that do not apply to high vacuums.

Referring to page 4214, he states: "The Compressor Cylinders, when employed for purposes of producing vacuum, are seldom water jacketed. A jacket is hardly necessary

since the air which is compressed, although it has the same temperature range as when compressed under corresponding ranges above the atmosphere, has less capacity for heat, due to its rarefied condition. This lack of heat capacity of air under pressure, below normal, obviates the use in most instances, of intercoolers for "two stage compression." While for low vacuums this is probably true, but when working with vacuums above 27 degrees of mercury, is is absolutely essential that the cylinders be thoroughly water jacketed, in order to maintain proper lubrication. It is also desirable that the intercooler be used in two stage machines for high vacuum service. If water jackets are not employed, it takes but a very short time for the temperature of the cylinder to reach the point where it vaporizes the lubricating oil, which, when mixed with the incoming air, forms an explosive mixture that is sure of ignition, if the vacuum pump is allowed to run for any length of time. It would seem that this might not be expected, because of the low heat capacity of the air at this low pressure, however, the above is the experience of many installations, using high vacuums.

Yours very truly,

CHARLES H. HILLIS.

DOORS TO OPEN BY AIR

In connection with the improvements which George S. Rice, chief engineer of the Rapid Traisit Commission, hopes to provide for the new subways, authority was obtained from the commission for pipe galleries along the routes of the new lines in Manhattan. Mr. Rice got permission to include in the specifications a clause which will call for cars without platforms but with doors about one-quarter of the length of the car at either end. These doors are to be opened by compressed air.

The remarkably simple and sensible suggestion is made at New York that the streets of the city be cleaned by pneumatic machines which would suck the dust into hoppers. Machines of this kind are used in Germany, and their employment in the United States should not be long delayed. Most cities are in especial need of intelligent street cleaning of this kind. The heavy streets cars and the whirling wind stir the dust into the air until the people are compelled to breathe day after day the germs from the street debris.

INDUSTRIAL.

BIG CONTRACT AWARDED

The Pennsylvania and the Baltimore and Ohio Railroad Companies, recently, jointly awarded the contract for the interlocking and signalling of the terminal station being built at Washington, D. C., to the Union Switch and Signal Company of Swissvale, Pa. The installation will be electro-pneumatic, similar in general characteristics to that in the yards of the Pennsylvania at the Union station in Pittsburg. The Washington installation, however, will be the largest and most complicated signaling and interlocking system ever constructed in the world.

The largest one previous to this was put in service at St. Louis at the beginning of the World's Fair, and previous to that the most important was the electro-pneumatic interlocking system at the terminal of the Boston South Station. Both plants were also installed by the Union Switch and Signal Company.

Work in connection with the terminal improvements at Washington is progressing rapidly and is about completed.

THE Traylor Engineering Co., of New York has entered into a contract where by Shirley and Grant, of Reno, Nevada, become exclusive representatiives of that house for the State of Nevada, for the sale of their machinery for mining, sampling, rock and ore crushing, milling, cyaniding, amalgamating, smelting, refining, fuel briquetting and completed.

A close relationship has been established under which the two houses will co-operate in designing and building entire plants, as well as in the sale of individual prices of machinery. Shirley and Grant are well known in the Nevada territory, both as a firm and as individuals, and they have many friends among the mining fraternity.

The Foundation Company of New York is engaged in sinking a shaft at the Syracuse mine of the Missabe iron range. The method used is entirely new on the range and is similar to that adopted in sinking caissons for buildings in the large cities. The work of concreting the walls of the old shaft at the Syracuse down as far as the water level has been completed. A roof of concrete is now being

constructed across the shaft at the water level. Through this roof is set a section of air tight circular steel shafting through which compressed air is admitted to the workmen below the roof and through which the workmen will descend and ascend to and from their work. The steel shafting will be built in sections to the top of the shaft and capped with the section that contains the trap doors through which the men enter and leave the shaft.

Much difficulty has been experiences in sinking a shaft at this property, but within a short time the contractors hope to have the shaft bottomed in ore. The company has installed an air compressor of 400 horse-power, capable of developing a capacity of 1,600 cubic feet per minute, a receiving tank, a smaller compressor with engine for operating same.

THE LITTLE GIANT CORNER DRILL

The Chicago Pneumatic Tool Company Fisher Bldg., Chicago, announces that they now have ready for the market a new "Little Giant" Drill for corner work. From past experience in air-tool practice the company claims to be justified in the statement that this drill surpasses any other drill for drilling in close quarters, and in corners particularly the machine having been designed especially for work of the latter class. The parts for the No. 4 Little Giant Drill interchange with the new drill, thus insuring quick repairs.

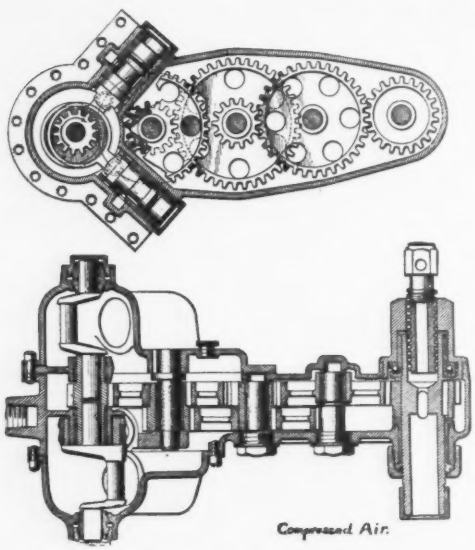


FIG. 1. CHICAGO CORNER DRILL.

This new tool weighs but 35 pounds, has a nominal capacity for drilling 1½-inch holes, but in emergency will drive 2-inch twist drills with satisfactory results. The spindle speed, when running light, is 150 R. P. M., and under load, with 80 pounds air pressure, 100 R. P. M. The distance from the end of the socket to the end of the feed screw, when run down, is 5⅞ inches, the length of feed 2 inches, and the distance from the centre of the spindle to the outside of the housing 1 5-16-inch.

FIG. 2. CHICAGO MIDGET DRILL.

According to the claim of the builders, in addition to being the most powerful drill ever built, weight considered, it possesses advantages over other designs of corner drills, owing to the spindle being driven by gears instead of by ratchet and pawl, which insures steady and constant spindle movement.

The accompanying illustrations give a clear idea of the construction of the drill and its neat and compact appearance. An exterior view of the drill as shown in Figure 3 and Figure 1 gives a sectional plan and sectional elevation which bring out all the important differences between this drill and the Little Giant drills previously manufactured by this company, so that further description is unnecessary.

The air motor movement and the handle controlling the inlet of air are unchanged, in

principle at least, but where the drill spindle would normally occupy a position in line with or not more than once removed from the motor shaft, three intermediate gear shafts are interposed. This gives an excellent opportunity for locating the speed-reducing gears in a convenient manner, and generally compacting the construction, so that the entire machine is of short length taken in the direction of the axis of the spindle. The case is oil-tight, to hold lubricant for motor and gears.

The Chicago Pneumatic Tool Company are also placing on the market a most unique air drill known as the "Chicago Midget" (rotary drill), shown in Figure 2, which is designedfor drilling up to and including 3-16-inch holes in steel. The weight of this drill is only 2½ pounds, distance from the top of breast plate to end of spindle 7⅝ inches, distance from the center of spindle to outside of housing 1 inch, motor speed 22,000 R. P. M., and spindle speed 2,000 R. P. M.

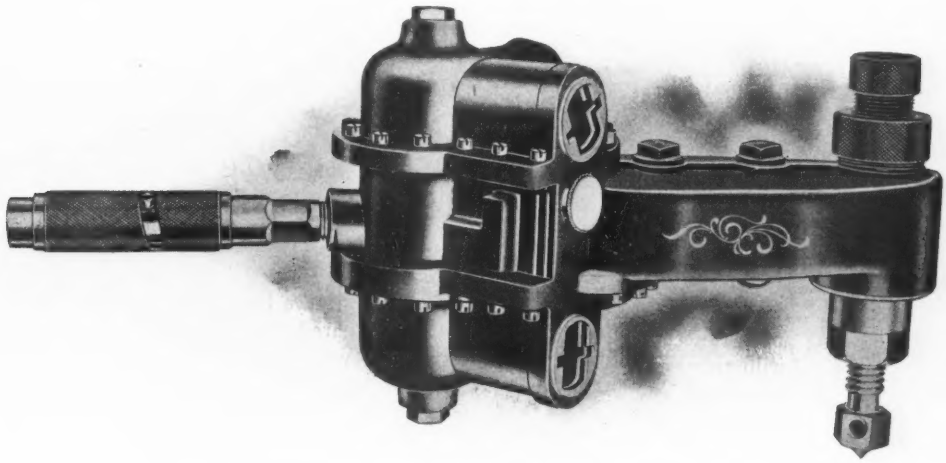


FIG. 3. EXTERIOR VIEW OF LITTLE GIANT CORNER DRILL.

AIR CONTROLLED MOTOR CAR

Air brakes have long been in use on every railroad in the country. They were adopted because of their proven efficiency and their demonstrated superiority over any form of hand brake. The power of an air brake is far in excess of a hand brake. It can be operated with no trouble, no effort. So, when a year ago it was announced that the Northern Motor Car Company of Detroit had under construction an air-controlled motor car, keen interest and curiosity as to the outcome pervaded automobile circles.

Compressed air is applied to the clutch of Northern Model "L" by means of an air compressor operated by the motor. Air is conducted through a hollow crank shaft to the hollow centre of the flywheel, which contains a steel clutch disc between two leather diaphragm discs. A movement of a lever on the steering column admits compressed air to the centre of the clutch at a pressure of about 75 lbs to the square inch, an aggregate pressure of about three tons and engages the clutch instantly and yet without any jerking and jarring. When the car is started on the high speed not the slightest change is felt by the driver or passengers. The air clutch is an extremely simple affair and consists of the three main parts before described. It is claimed and a 10,000-mile test is back of the claim that the car can be run through an entire season without a single adjustment of the clutch. The clutch being housed in the flywheel, in an airtight compartment, is oil retaining and no dirt or dust can get in. This feature alone makes strong appeal to the motorist who knows—who has had experience in adjusting the clutch.

CHIPPINGS.

THE Piqua Blower Company of Piqua, Ohio is being incorporated under the laws of Ohio, with a capital of $50,000. This corporation will take over the interests of the Piqua Foundry and Machine Company of Piqua, Ohio, and will make a specialty of the manufacture of positive blowers and gas exhausters as developed by the later company in the past two years. As the machinery of the latter firm has met with great success, it is necessary to effect this reorganization in order to take care of the large volume of business offered.

SUCCESSEUL ADOPTION OF COMPRESSED AIR.

The Balfour Quarry Co. is successfully employing compressed air in creating artificial bed seams in its Pink Granite Quarry, near Salisbury, N. C. Up till recently it has been supposed that the compressed air method could not be used on this granite, which is exceedingly close grained and compact. The beds so created are level and smooth. Recently a block containing about sixteen thousand cubic feet was detached with remarkably little waste.

AN INTERESTING PISTON PACKING

For steam and gas engines, pumps, air compressors, &c., a novel form of piston packing is made in Glasgow. It consists of three rings the two outer ones being the packing rings proper, while the inner one is the tension ring. This has about double the amount of spring power possessed by the other two, and its construction is such that it does not touch the cylinder walls, its pressure being transmitted to the other two rings instead. It fits them at such an angle that the resultant side pressure tends to lock the bearing rings in the groove, and thus produce a semisolid piston. In this way it avoids the defect common to steam-set packing rings, of wearing the cylinder bore large at the ends, where the steam pressure is greatest. For steam, the packing is made of a special cast iron, and for water pumps of a special bronze. The construction is simple, being straight lathe work, with no hand fitting required. This packing is particularly recommended for use with superheated steam at high piston speeds.

In the operation of air compressors the best results are obtained, it is said, when the areas of the suction and discharge valves are equal and of such proportions that the velocity of the air does not exceed 5,500 ft. per minute. On a compressor running at a piston speed of 550 ft. per minute, this requires a valve area equal to 10 per cent. of the piston area. The practice of making suction valve areas larger than those of the discharge valves is not advised, as, while the incoming air is of greater volume, the discharge valves remain open for a very small proportion of the stroke.

It is claimed that when drilling in sandstone the drill-bit should be tapered somewhat and then flattened instead of drawn to a cutting edge. If a chisel-bit is used in drilling sandstone, the bit will wear very sharp, and will frequently become fitchered.

Rock drill pipe lines, says the *Mining Reporter*, which have become choked by freezing may be cleared by turning a very small amount of wood alcohol into the line. This will not prevent freezing for any length of time, but will be of the greatest aid in loosening frost already formed.

An interesting example of the use of magnetism in an emergency occurred recently in Philadelphia. At the Mint a well has been bored which has reached a depth of some 54 feet. A few weeks ago one side of the jar rein of the drill, 18 inches long and weighing 110 pounds, broke off and wedged crossways in the hole at the bottom. The contractor doing the work fished ten days trying to recover the broken piece without result. The problem was solved by the construction of an improvised electro-magnet consisting of a piece of steel 33 inches in diameter, on one side of which was wound a coil protected by a copper sheathing. Long leads were attached and the apparatus was lowered down the boring. The current, 1¾ amperes, at 220 volts, was then turned on, and the magnet was pulled up, bringing with it the broken tool and all the metal particles that were in the well from the boring.

Where compressed air is available, the small air-hammer drill may prove to be an excellent tool for use in sampling a hard vein. The machine should be provided with a moil-shaped bit, instead of with the ordinary blunt-chisel bit usually employed in drilling. The success of the use of this device depends largely upon the practical sense of the man manipulating the machine. The air-hammer drill has proved its usefulness in rapidly drilling shallow holes, and there seems no good reason why in competent hands it should not be useful in cutting a channel of uniform depth and width across a vein of hard rock of any description.—*Mining and Scientific Press.*

ABOUT FORGING BITS.

In forging rock drill bits those for medium hard rock should have sharp chiseled bits. As the hardness of the rock increases, the angle of the bit may be made more blunt and the cutting edge shaped from a straight line to a curve, so as to prevent the corners from being chipped off. There are economies in the foregoing bits to the best advantage with reference to the stone that is being worked especially, which would constitute quite a factor in the whole cost of the quarrying operation, for it costs just as much to work with a bit that is doing very little actual cutting as it does to operate where every blow is cleaving straight into the stone.

The cost for motive power, whether it is for steam or compressed air and the wages of the man working the drill goes on just the same, whether he is idly pounding or whether his tool is cutting properly. A little experimentation on the part of the man who forges the tools is in order in many quarries where the thing is being done in a slipshod manner. It is very easy to find out just what kind of a bit yields the best result, and this should be the pattern for all other bits working in the same kind of strata. Of course in most large quarries, the rock varies considerably, and it is well for the man who operates the drill to change his bit to suit the specific kind of a cut that he is making. The man who forges the bits should have every kind that will be called for, provided to be furnished on a moment's notice.

According to the *Engineering Record,* compressed air locomotives are used in handling the 11,700 tons of ore, limestone, coke and coal brought daily to the Washoe plant of the Anaconda Copper Mining Co. Counting rehandled materials twice, more than 13,000 tons are handled about the works by means of thirteen compressed-air locomotives, twelve weighing 13 tons each, and one, 21 tons. Each locomotive carries two storage-tanks for its air-supply, the air being taken from a pressure-system of pipes laid conveniently to the tracks, and having stations at which the locomotive stops to get its air-supply. This supply is carried at from 800 to 900 lbs. per square inch. A reducing-valve between the storage-tanks and the cylinder reduces the pressure to 150 lbs. A fresh supply of air is taken at times ranging from twenty to sixty minutes. For this particular service, where the distances run are short, and where the cars are frequently stopped and started, the compressed-air locomotives have been most satisfactory, for convenience, reliability and simplicity of operation. They have been in constant service since 1900, and have needed only the natural running-repairs. They are operated over tracks aggregating 48 miles in length, which are distributed over the side-hill location of the works about half a mile square. The present locomotives have been able to stand the hardest and roughest usage with but little injury. Under like conditions, it is believed that electric locomotives would have had coils burned out, short-circuiting and other troubles.

THE weakest point in electrical transmission, is the absence of proper means for storing electrical energy on a large scale at a reasonable cost. This requires that the whole plant be capable of supplying current at the greatest rate still likely to be called for at any moment, and still provide an ample reserve of capacity in case of a break down in any part of the system. In this connection, the advocates of gas claim that this latter power can be readily and cheaply stored in quantity, for any desired length of time, and used at whatever moment and in any amount without deterioration or loss. The plant, if necessary, may be shut down for a time without interrupting the supply. Until recently, however, it has not been considered possible to convey gas with any success over long distances. This has been due to a lack of efficient compressors, and of pipes and joints not capable of withstanding, without excessive leakage, the pressures which would have had to be employed. With air compressors having a total efficiency as high as 77 per cent., and steel pipes capable of carrying high pressures and obtainable in longer lengths, thus reducing the number of joints, gas is becoming a power which in many cases compares favorably with electricity.—*Engineering and Mining Journal.*

PROPORTIONING CONCRETE

In a paper by Sanford E. Thompson, read before the Boston Society of Civil Engineers, the author, after discussing various methods and tests, offers the following suggestions as guides to proportioning concrete:

1. The size of the largest stone in the aggregate should be as great as is consistent with proper placing of the concrete.

2. If size of stone is small, a richer mixture must be used; thus 1:3:6 is a fairly rich mix with 2-inch stone, but a lean mix with ½-inch stone.

3. If sand is fine, a smaller quantity may be used in proportion to the stone.

4. For concrete a sand with too large a percentage of very coarse grains may be detrimental because they will not fit into the voids of the coarse aggregate.

5. If the broken stone or gravel contains fine stuff, a smaller proportion of sand must be used.

6. Better proportions are obtained in practice by screening the sand or dust from the coarse material and remixing in required proportions, than by using the run of the bank or the run of the crusher.

7. If the mortar in concrete is rich, say, up to 1:2½, sand should be coarse, with comparatively few fine grains. A lean mortar, on the other hand, is improved not only in strength but in smoothness of working, by using a sand containing dirt or dust.

8. If fine sand must be used, the proportions must be richer than for coarse sand, because a fine sand makes a mortar of lower density.

MACHINE AND HAND DRILLING.

The rate at which a tunnel can be driven by means of rock-drills may be safely taken at double the speed of hand-work. Thus, in driving the Vosburg tunnel (8 by 20 ft.) on the Lehigh Valley Railroad, through a uniform hard gray sandstone, by hand drilling, the progress was 67 ft., while by machine-drilling it was 173 ft. monthly. For driving or for sinking, rock-drills are far superior to hand-labor, both in speed and in economy. For stopping, however, except in wide stopes, the differences are not so marked, as it is difficult to maneuver a machine in places where a man can hardly find room to work with a single-hand hammer. The great advantage in the use of rock-drills is undoubtedly the increased speed with which a mine can be developed and ore reserves created, since, for cost per yard, there is not much difference between either that or hand-drilling. The point is a little difficult to decide, but it would be safe to say that the average cost per yard by either system is the same for ordinary mine drifts, while, for full-sized tunnels, machine-drilling is cheaper.—*Mining and Scientific Press.*

AT several mines in Europe small compressors, electrically driven, have been installed underground, each compressor serving a group of drills. The compressor motor and receiver are sometimes arranged on a truck, which can be moved to follow the development of the mine. The electrical cable is wound on a drum, enabling the easy adjustment of the length.

The efficiency of these installations has been found very good. By this method the theoretical advantage of the electric drill is approached, while the practical advantage of the air drill is retained.—*Engineering and Mining Journal.*

WHERE compressed air is used, the initial energy may be restored by adding a slight amount of heat to the air at the point of application; in fact, the employment of a re-heater increases the volume to such an extent that additional energy is gotten when air is used expansively at a rate of 1 H. P. per lb. of coal. In mine operations the re-heater is never pushed to its limit, so that it will not interfere with the comfort and health of the men. Compressed air is only raised in temperature slightly to make up for the transmission drop in pressure.

IN compressed-air haulage no serious difficulty from freezing in the exhaust passages of the locomotive will be encountered if high pressures are used. Only in case of low pressure will freezing occur. Where higher pressure is used, practically all of the moisture is squeezed out of the air in the process of compression and deposited in the stationary storage, or in the tanks on the locomotive, whence it can be drawn off at intervals. The only other cause of freezing may be the use of a poor quality of oil.

835,936. PNEUMATIC HAMMER. CHARLES T. CARNAHAN and JEREMIAH MURPHY, Denver, Colo.; said Murphy assignor to said Carnahan. Filed June 28, 1906. Serial No. 323,944.

Claim.—A pneumatic hammer comprising a throttle-valve mechanism positioned at right angles with respect to the cylinder of the hammer, said mechanism having as a part thereof, an air-inlet nipple extending at right angles with respect thereto.

836,101. APPARATUS FOR CIRCULATING LIQUIDS IN DYE-VATS. LOUIS DUMONS, Roubaix, France. Filed June 12, 1903. Serial No. 161,156.

836,105. LOAD-BRAKE APPARATUS. CLYDE C. FARMER, Chicago, Ill., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a Corporation of Pennsylvania. Filed Feb. 17, 1904. Serial No. 194,109.

836,124. LOAD-BRAKE APPARATUS. HARRY R. MASON and CLYDE C. FARMER, Chicago, Ill., assignors to Westinghouse Air Brake Company, Wilmerding, Pa., a Corporation of Pennsylvania. Filed Feb. 17, 1904. Serial No. 194,101.

836,160. FLUID-PRESSURE BRAKE. HENRY H. WESTINGHOUSE, Pittsburg, Pa., assignor to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Feb. 19, 1904. Serial No. 194,348.

836,215. TUNNEL CONSTRUCTION AND METHOD AND APPARATUS FOR FORMING THE SAME. JESSE W. RENO, New York, N. Y. Filed March 5, 1906. Serial No. 304,310.

836,258. REDUCING-VALVE. JOSEF HUBNER and ISIDOR MAYER, Vienna, Austria-Hungary. Filed Feb. 19, 1906. Serial No. 310,918.

836,268. AIR-CUSHION FOR PRINTING-PRESSES. ROBERT MIEHLE, Chicago, Ill. Filed Dec. 19, 1902. Renewed Sept. 26, 1904. Serial No. 225,975.

836,306. REDUCING-VALVE. HARRY F. CUNNING, Roanoke, Va. Filed June 19, 1906. Serial No. 322,454.

836,320. PNEUMATIC BOBBIN-CONVEYER FOR MILLS. PATRICK J. HANLON, Leicester, Mass. Filed May 2, 1906. Serial No. 314,771.

836,344. AIR-BRAKE COUPLING. CARL SCHUMACHER, Newport, Ky. Filed June 11, 1906. Serial No. 321,215.

836,524. PNEUMATIC LIFE-SAVING SUIT. EDWARD MORRELL, San Quentin, Cal. Filed June 14, 1904. Serial No. 212,577.

836,532. PNEUMATIC GUN OR RIFLE. JAMES PICKEN, Port William, Scotland, assignor of one-half to Arthur Allan, Jr., Glasgow, Scotland. Filed Dec. 30, 1902. Serial No. 137,115.

836,624. AIR COMPRESSING AND COOLING APPARATUS. RUDOLF BERG, Pittsburg, Pa., assignor of one-half to Ferdinand Wenig, Pittsburg, Pa. Filed April 22, 1905. Serial No. 256,836.

Claim.—In an air compressing and cooling apparatus, the combination of two casings of cross shape arranged sidewise of each other, a horizontal cylinder supported at the meeting joint of said casings, said cylinder being open at both ends, a piston reciprocating in said cylinder, spiral isothermal coils supported in the lower parts of the extension-cylinders, of the casings, discharge-valve chambers supported on said extension-cylinders and axially in line therewith, suction-tubes extending through the extension-cylinders and discharge-valve chambers, fillet-rings located on said suction-tubes in the discharge-valve chambers, suction-vales located on the lower parts of the suction-tubes, discharge-valves guided on said fillet-rings, perforated valve-seats for the suction and discharge valves, the suction-valve seats being located at the lower ends of the suction-tubes and the discharge-valve seats in the bottom part of the discharge-chambers.

836,630. PUNCH OR RIVETER. SAMUEL S. CASKEY, Philadelphia, Pa. Filed Feb. 7, 1903. Serial No. 142,330.

Claim.—In a riveter or punch, a stationary non-compressible reservoir adapted to normally contain oil or other liquid and communicating directly with the riveting-chamber, and having an outlet in proximity to the central portion of said reservoir, said outlet being normally always beneath the surface of said liquid, and means for admitting a slight leakage of compressed air upon the surface of said liquid.

836,682. AIR-BRAKE SYSTEM. GEORGE R. HENDERSON and WALTER V. TURNER, Topeka, Kans., assignors to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Nov. 13, 1902. Serial No. 131,240½.

836,705. AIR-BRAKE SIGNAL SYSTEM. THOMAS J. QUIRK, Buffalo, N. Y. Filed June 20, 1906. Serial No. 322,587.

836,716. PNEUMATIC WHEEL. GEORGE H. TREADGOLD, Port Huron, Mich. Filed Dec. 16, 1905. Serial No. 292,061.

836,720. REGULATOR-VALVE FOR AIR-BRAKE SYSTEMS. WALTER V. TURNER, Topeka, Kans., assignor to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Jan. 2, 1903. Serial No. 137,554.

836,772. PROCESS OF MANUFACTURING PNEUMATIC TIRES. ARTHUR H. MARKS, Akron, Ohio. Filed Jan. 13, 1906. Serial No. 295,952.

836,778. PNEUMATIC HAMMER. ALLEN J. PATCH, Beloit, Wis., assignor to Fairbanks, Morse & Company, Chicago, Ill., a Corporation of Illinois. Filed July 6, 1904. Serial No. 215,555.

Claim.—In a pneumatic hammer a cylindrical shell valve provided with three seating surfaces and an inclined surface, in combination with a valve seat having an annular passage adapted to be closed by said valve in one position and opened by the shifting of said inclined surface, substantially as described.

836,824. ROCK-DRILL BIT. JOHN B. PACE, New York, N. Y. Filed Nov. 21, 1905. Serial No. 288,347.

836,846. ROCK-DRILL. WILLIAM C. WHITCOMB, Chicago, Ill. Filed Nov. 2, 1905. Serial No. 285,617.

836,883. BURNER. BENJAMIN F. JACKSON, Boston, Mass., assignor to Boston Crude Oil Burner Co., Boston, Mass., a Corporation of Maine. Filed July 8, 1904. Serial No. 215,709.

836,886. QUICK-RECHARGING TRIPLE VALVE. WILLIAM B. MANN, Baltimore, Md., assignor to American Air-Brake Company, a Corporation of New Jersey. Filed July 1, 1903. Serial No. 163,949.

836,973. SYSTEM OF MOTOR CONTROL. GEORGE H. HILL, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed May 20, 1905. Serial No. 261,293.

836,981. TRAIN-CONTROL SYSTEM. CHARLES E. LORD, Cincinnati, Ohio, assignor to General Electric Company, a Corporation of New York. Filed Oct. 1, 1904. Serial No. 226,749.

837,037. MOTOR-CONTROL APPARATUS. FRANK E. CASE, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed April 17, 1905. Serial No. 255,868.

837,086. PNEUMATIC CUSHION FOR VEHICLES. ANDREW M. LOCKETT, New Orleans, La. Filed April 28, 1906. Serial No. 314,162.

837,098. HOSE-COUPLING FOR RAILROAD-TRAINS. ALEXANDER F. MORTON, Pittsburg, Pa. Filed Sept. 29, 1906. Serial No. 336,785.

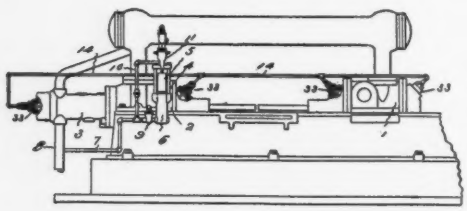
837,118. ROCK-DRILL. JOSEPH J. REKAR, San Francisco, Cal. Filed April 13, 1906. Serial No. 311,461.

837,207. MASSAGE-PUMP. HENRY P. ENGELN, Cleveland, Ohio, assignor to The H. P. Engeln Company, Cleveland, Ohio, a Corporation of Ohio. Filed Sept. 29, 1904. Serial No. 226,482.

837,327. MECHANISM FOR UNLOADING AIR COMPRESSORS. HENRY P. MORGAN, Norwalk, Conn., assignor to The Norwalk Iron Works Company, South Norwalk, Conn., a Corporation

of Connecticut. Filed Aug. 12, 1905. Serial No. 273,905.

Claim.—1. In an apparatus for relieving the pistons of a multiple-stage compressor, the combination with an inlet-valve of each cylinder, of a plunger located adjacent to and adapted to be actuated by air-pressure for rendering inactive each inlet-valve, a connection for air extending between the discharge of the high-pressure cylinder and each plunger-chamber, a valve normally closing the air-passage through said connection, a piston adapted to open this valve, a connection for air for actuating said piston, and a valve set to open at the desired pressure in the connection to the piston-cylinder, substantially as specified.



837,347. ROCK-DRILL. Clark J. Smith, Ottumwa, Iowa, assignor to The Hardsocg Wonder Drill Co., Ottumwa, Iowa. Filed July 5, 1906. Serial No. 324,804.

Claim.—1. In a rock-drill, the combination with the hammer-barrel and the hammer, said barrel having an inlet and an exhaust chamber, of a drill having an longitudinal passage therethrough and held in one end of said hammer-barrel, said barrel having a water-chamber, means for admitting water into said water-chamber to pass through said drill, said hammer-barrel having a valved passage between the exhaust and the water chambers, and means for controlling the water admission to the water-chamber, substantially as shown and described.

837,358. LOCAL-APPLICATION AND EQUALIZING VALVE. Walter V. Turner and David M. Lewis, Raton, N. Mex., assignors to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Oct. 4, 1902. Renewed March 24, 1905. Serial No. 251,847.

837,369. ELECTRO-PNEUMATIC BRAKE. Edward Wright, Edgewood Park, and Walter V. Turner, Wilkinsburg, Pa., assignors to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed March 20, 1905. Serial No. 250,988.

837,416. AIR-BRAKE. Hugh M. Marsh, Chicago, Ill. Filed July 16, 1906. Serial No. 326,402.

837,458. PNEUMATIC TIRE. Harry C. Fairchild, Passaic, N. J. Filed March 30, 1905. Serial No. 252,862.

837,772. SAFETY-VALVE FOR PNEUMATIC TIRES. William S. Arnold, San Francisco, Cal. Filed June 2, 1906. Serial No. 319,949.

837,856. PNEUMATIC TOOL. Herman Leineweber, South Chicago, Ill., assignor of one-half to William M. Bayne, Chicago, Ill. Filed Aug. 27, 1906. Serial No. 332,124.

Claim.—1. In a pneumatic tool, the combination of a casing carrying at one end the tool, a reciprocating piston in the casing, air-chambers in the opposite ends of said casing, between which the piston works, one of said chambers having a supplemental inlet-port communicating with

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837,990. VALVE-GEAR FOR PNEUMATIC ROCK-DRILLS. Carl Weidman, Würselen, Germany, assignor of one-half to Paul Hoffman, Eiserfeld, near Siegen, Westphalia, Germany. Filed June 17, 1905. Serial No. 265,649.

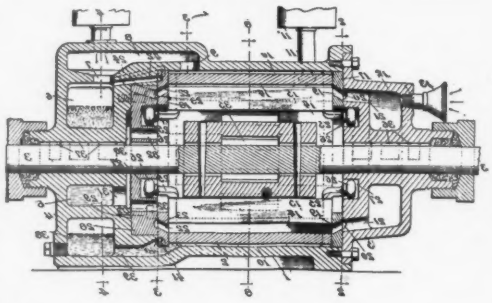
838,103. CAR AND AIR-BRAKE HOSE-COUPLING. William W. Gordon, Washington, D. C. Filed Aug. 15, 1906. Serial No. 330,724.

838,106. PNEUMATIC CUSHION FOR VEHICLE-SPRINGS. Caleb S. Gurney, Portsmouth, N. H. Filed Dec. 18, 1905. Serial No. 292,315.

838,138. AUTOMATIC APPARATUS FOR PREVENTING COLLISION OF RAILWAY TRAINS. Maurice Privat Ingumbert, Paris, France. Filed Jan. 23, 1904. Serial No. 190,368.

838,140. AIR-COMPRESSOR. Lebbeus H. Rogers, New York, N. Y. Filed Feb. 2, 1905. Serial No. 243,868.

Claim.—1. In a compressor, a cylinder, a drum revolving in said cylinder, a piston in said drum, an oil-chamber, a conduit leading therefrom to the rear of said piston, and means operated by the drum for delivering oil from said cylinder to said oil-chamber.



838,141. SIGNAL APPARATUS. Hermann Sandvoss, Neuss, Germany. Filed April 5, 1906. Serial No. 309,983.

838,308. STOP-COCK FOR AIR-BRAKE SYSTEMS. Samuel H. Dunning, Paterson, N. J. Filed April 7, 1906. Serial No. 310,514.

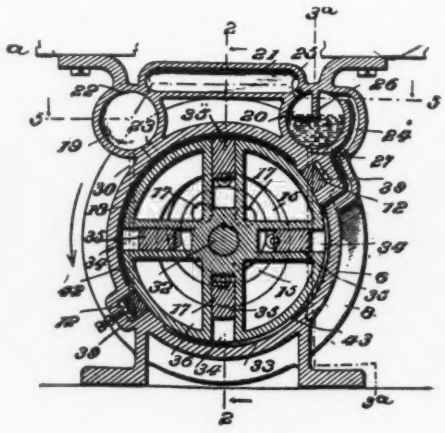
838,336. AIR-LOCK. Henry Japp, New York, N. Y., assignor to S. Pearson & Son, Inc., Long Island City, N. Y., a Corporation of New York. Filed April 20, 1906. Serial No. 312,936.

838,337. VALVE FOR AIR-LOCKS AND THE LIKE. Henry Japp, New York, N. Y., assignor to S. Pearson & Son, Inc., Long Island City, N. Y., a Corporation of New York. Filed Sept. 10, 1906. Serial No. 334,009.

838,363. POWER-HAMMER. Harry B. Stocks, Manchester, England, assignor to The Climax Patents Limited, Manchester, England. Filed Aug. 31, 1905. Serial No. 276,600.

838,42. COMPRESSED-AIR RAILWAY-TRAIN BRAKE. Adolph A. Osoling, St. Petersburg, Russia, assignor to Oscar Mietens, St. Petersburg, Russia. Filed May 31, 1906. Serial No. 319,601.

838,458. ROTARY COMPRESSOR OR PUMP. Lebbeus H. Rogers, New York, N. Y. Filed Sept. 9, 1904. Serial No. 223,913.



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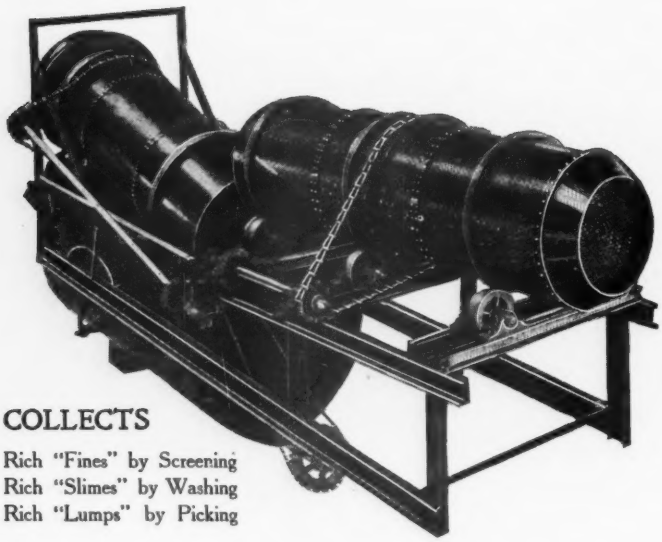

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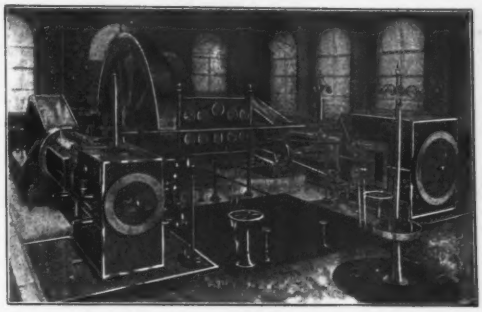

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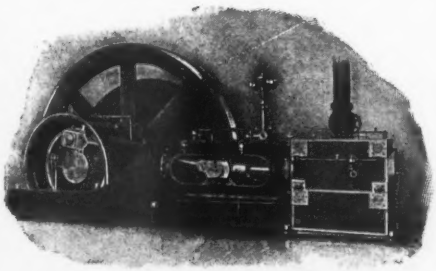

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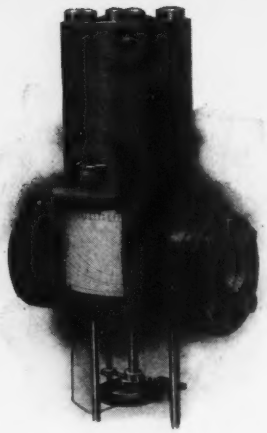

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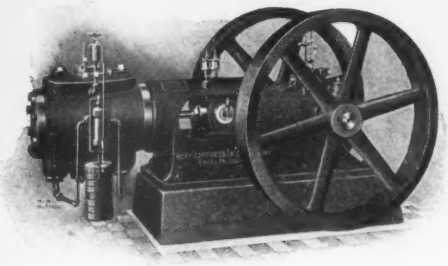

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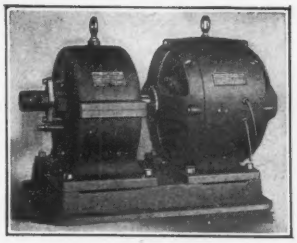

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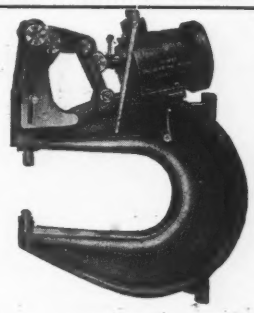

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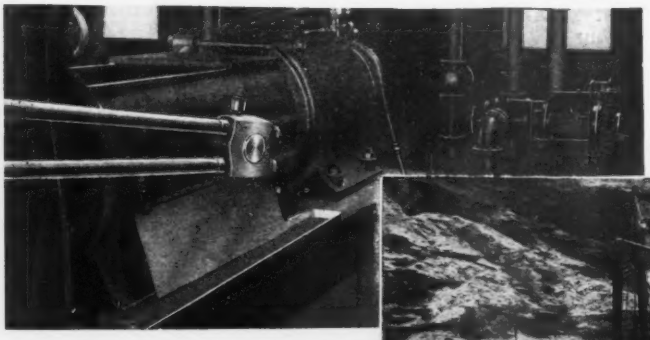

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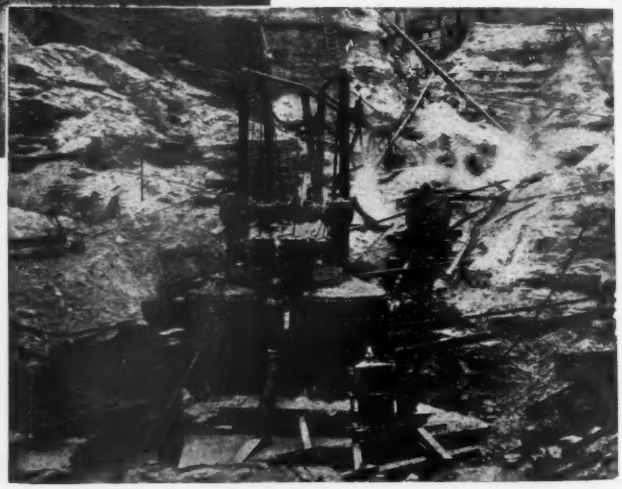

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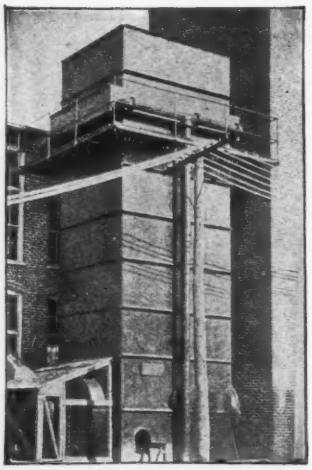

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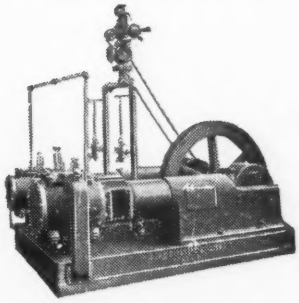

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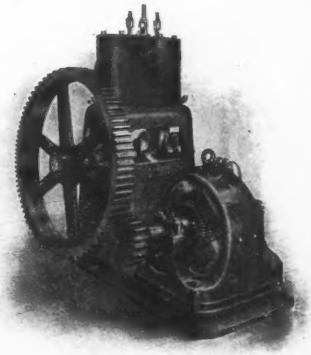

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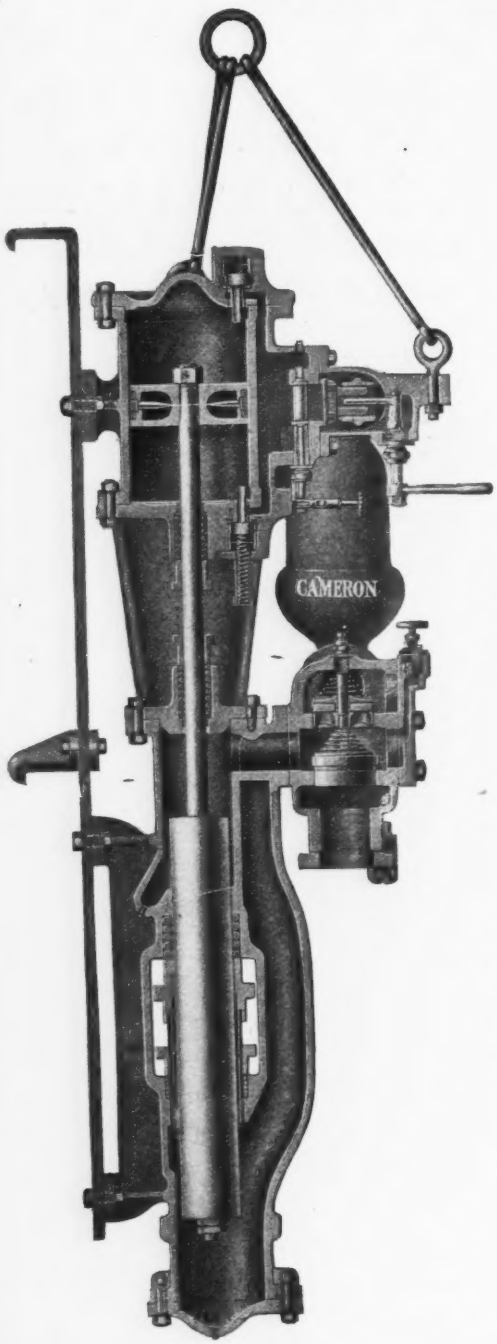

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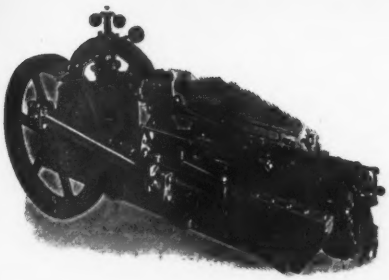

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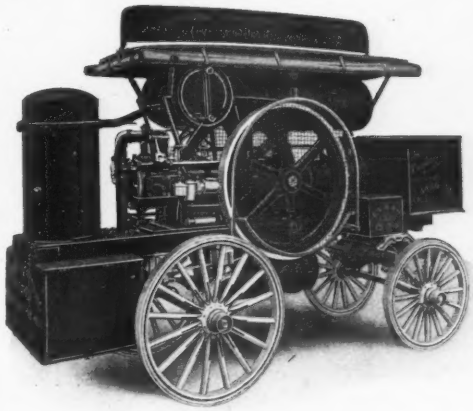

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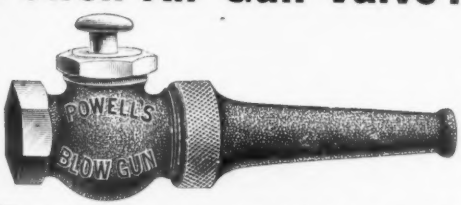

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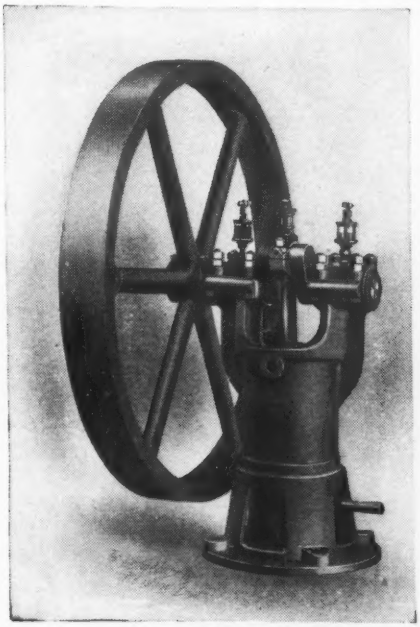

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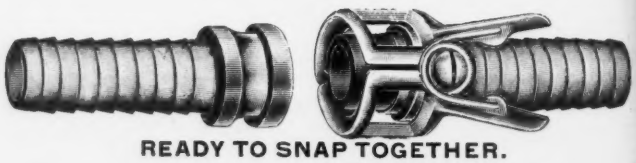

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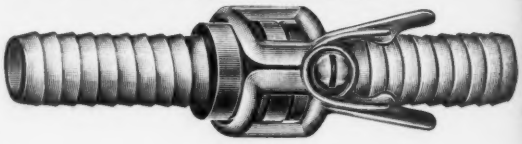

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